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Studies on genetic variability, heritability and genetic advance in tomato

NITISH KUMAR ● ML BHARDWAJ ● SANTOSH KUMARI ● ANKITA SHARMA

ABSTRACT The present investigation was carried out to estimate variability, heritability and genetic advance in diverse germplasm of tomato. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Thirty five genotypes including one check cultivar were evaluated for different horticultural traits. High phenotypic and genotypic coefficients of variation were depicted for the characters like number of fruits per plant (51.80 and 50.00 %), fruit yield per plant (52.18 and 51.10 %), fruit yield per plot (53.21 and 51.91 %), fruit yield per ha (53.21 and 51.91 %) and plant height (36.85 and 36.38 %). High heritability coupled with high genetic gain was recorded for number of fruits per plant (93.18 and 99.42 %), plant height (97.45 and 73.98 %), average fruit weight (95.11 and 50.09 %), fruit yield per plant (95.89 and 103.00 %), per plot (95.19 and 104.34 %) and per hectare (95.19 and 104.34 %). High heritability coupled with high genetic gain was recorded for number of fruits per plant (93.18 and 99.42 %), plant height (97.45 and 73.98 %), average fruit weight (95.11 and 50.09 %), fruit yield per plant (95.89 and 103.00 %), per plot (95.19 and 104.34 %) and per hectare (95.19 and 104.34 %). High heritability coupled with high genetic gain was recorded for number of fruits per plant (93.18 and 99.42 %), plant height (97.45 and 73.98 %), average fruit weight (95.11 and 50.09 %), fruit yield per plant (95.89 and 103.00 %), per plot (95.19 and 104.34 %) and per hectare (95.19 and 104.34 %). Hence, selection based on above characters can prove effective for improvement in yield. High heritability coupled with moderate genetic gain was observed for number of fruits per cluster, harvest duration and ascorbic acid content. Therefore, these characters also show some scope for improvement in yield through selection in tomato.

INTRODUCTION

Tomato (Solanum lycopersicum L.) is the world’s largest grown vegetable crop after potato and sweet potato, occupying prime position among processed vegetable (Kumar 2010). It is one of the most popular vegetable in India and is grown in tropical, subtropical and mild cold climate regions on an area of 767 thousand ha with an annual production of 16385 thousand MT (Anonymous 2015a). Versatility of tomato in fresh and processed form plays a major role in its rapid and wide spread adoption as an important food commodity. Its fruits are good source of vitamin A and C as well as contain antioxidant such as lycopene which prevents cancer (Bhutani and Kallo 1983).

Tomato serves as an important off-season vegetable crop in Himachal Pradesh and is grown during summer and rainy seasons as the climatic conditions are congenial for optimum plant growth and yield. The annual production of tomato in Himachal Pradesh is 458 thousand MT from an area of 11.03 thousand ha (Anonymous 2015b). Information on nature of total phenotypic variability together with the magnitude of heritability for any given quantitative character under improvement is of utmost importance to the breeder to proceed towards fruitful hybridization programme for development of superior varieties/hybrids. Yield improvement would be facilitated only when genetic variability exists in the material chosen for improvement. The genotypic and phenotypic coefficients of variation are useful in detecting amount of variability present in the available genotypes. Heritability and genetic advance help in determining the influence of environment in expression of the characters and the extent to which improvement is possible after selection. Hence, the study was conducted to quantify the amount of
Genetics of yield and its components in rice bean under mid altitude areas of Mon district Nagaland India

MS SACHAN
Received: May 4, 2017, Revised: September 16, 2017, Accepted: September 20, 2017

ABSTRACT Genetic variability, correlation and path analysis for nine quantitative traits in nineteen genotypes of rice bean were studied at the Instructional Farm, Krishi Vigyan Kendra, Mon (Aboi), Nagaland under rainfed conditions during kharif 2015. Maximum phenotypic (PCV) and genotypic (GCV) coefficients of variation were observed in case of number of pods per plant (8.62 and 8.41 %) and days to 50 % flowering (8.08 and 7.88 %). Both heritability and genetic advance are high for number of pods per plant (95.33 % and 17.12) and days to 50 % flowering (95.68 % and 15.32). Days to 50 % flowering with grain yield per plant \( r_p = 0.63 \) and number of pods per plant with grain yield \( r_p = 0.89 \) and \( r_p = 0.86 \) indicates highly significant and positive correlation at genotypic and phenotypic level. Path analysis revealed that only days to 50 % flowering had showed high direct effect and highly significant positive correlation with grain yield per plant (0.848 and \( r_p = 0.781 \)), indicating the importance of selection based on this character to increase grain yield per plant.

KEYWORDS Rice bean, variability, heritability, genetic advance, correlation, path analysis, yield

INTRODUCTION
Apart from the traditional tropical pulses (green gram, black gram, pigeon pea, lentil, chickpea, pea etc.), rice bean has gained attention as supplementary food crop (Singh et al. 1980). Rice bean, also known as climbing bean, mountain bean, mambi bean, oriented bean, haricot bean, red bean, Jerusalem pea, is a highly branched annual with erect or sub-erect stem tending to be viny and tendrillar, axillary raceme inflorescence, bright yellow flowers occurring in clusters, pods slender and somewhat curved, seeds oblong with seed coat smooth, dark, green, yellow, brown, black, speckled or mottled. Five botanically distinct varieties of rice bean viz., major, glabra, rumbaiya, gracillis and macrocarpa are reported (Chandel et al. 1988). Rice bean is largely self pollinated diploid \( (2n = 22) \) but natural cross-pollination has also been reported (Sastrapadja and Sutarno 1977, Singh and Sarma 1993).

Rice bean is a native of south and South East Asia. As cultigens, rice bean occurs in India, Myanmar, Malaysia, China, Korea, Indonesia and the Phillipines (Chandel et al. 1988). It is also cultivated to a limited extent in West Indies, USA, Australia, East Africa, Java, Fiji, Bangladesh, Srilanka and Nepal ((Burkill 1935, Sarma et al. 2003). The cultivars are well adapted to sub-tropical dry to moist climate. The best performance is obtained with 24-28 °C temperature and 1500 to 2000 mm rainfall.

In India, its distribution is mainly confined to the tribal regions of North-Eastern hills and hilly tracts of Western and Eastern Ghats (Arora et al. 1980). In the North-Eastern region of India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura), rice bean is grown predominantly under rainfed conditions in a mixed
Rank based non-parametric measures of grain yield for rainfed barley genotypes evaluated in northern hill zone

AJAY VERMA ● J SINGH ● V KUMAR ● AS KHARAB ● GP SINGH
Received: April 17, 2017, Revised: September 12, 2017, Accepted: September 20, 2017

ABSTRACT Simple descriptive statistics based on ranks of 19 genotypes evaluated at 8 locations in northern hills of country showed HBL723 and HBL737 as stable genotypes, while BHS400 and UPB1044 based on MR, VLB118 and HBL113 based on SD and VLB118 and BHS400 based on CV were unstable genotypes. Huehn’s non-parametric measures based on original values indicated HBL72315, BHS43720 and HBL73716 were genotypes of stable performance, while VLB11811, HBL11319 were unstable genotypes. NP$_i$(1) pointed towards VLB144 and VLB118 as stable and UPB1043 along UPB1044 unstable while, NP$_i$(2) showed VLB144, BHS352 and UPB1044 as sable and unstable, NP$_i$(3) found out HBL723 VLB144 and BHS400 and NP$_i$(4) identified VLB144 HBL723 and BHS400 as the stable genotypes and overall by most of measures VLB144 HBL723 and BHS400 VLB118 were stable and unstable genotypes. Highly significant positive rank correlation of yield with CV, S$_i^3$ and S$_i^6$ and highly significant negative with MR and Med were observed. Yield expressed highly significant positive relationship with NP$_i$(2), NP$_i$(3) and NP$_i$(4).

KEYWORDS Non-parametric measures, Spearman rank correlation, Ward’s hierarchical clustering

INTRODUCTION
Improving crop yields for major cereals is essential to meet the increasing demand of food driven by the increasing population. Barley cereal is the world’s fourth important crop. In India, barley is staple food of the hill people and crop is cultivated for food and feed purposes. The presence of GxE interaction in crop breeding trials has led to the development of numerous stability parameters to estimate the stability of cultivars (Mortazavian and Azizinia 2014). Mostly two major approaches are explored to study GxE interaction and adaptation. First is the parametric or empirical approach, which relates genotypic responses to a set of environmental conditions (Akcura and Kaya 2008). Other is non-parametric or analytical approach cluster genotypes according to similarity in response to diverse environments (Dehghani 2008). These methods are based on ranks of genotypes, stable genotype show relatively constant ranks across environments (Karimizadeh et al. 2012). Non-parametric measures of phenotypic stability based on the ranks of genotypes in different environments was proposed (Huehn 1979, Nassar Huehn 1987, Rasoli et al. 2015). Non-parametric stability statistics were based on the ranks of adjusted means of genotypes in a set of environments. Relatively new researchers have utilized non-parametric measures of Huehn for stability assessment (Parmar et al. 2012, Rasoli et al. 2015, Khalili and Pour-Aboughadareh 2016).

MATERIALS AND METHODS
Nineteen promising barley genotypes were evaluated at 08 major barley producing locations in northern hills during 2014-15 cropping seasons. The field layout of trials was randomized block designs with three replications, moreover the details of environmental conditions and pedigree of studied
ABSTRACT Keeping in consideration the importance of sorghum in present day scenario of global warming, the present investigation was undertaken at GB Pant University of Agriculture and Technology, Pantnagar, during 2014-15. The nature and magnitude of gene effects through generation mean analysis was estimated for five traits of economic importance in sorghum [Sorghum bicolor (L.) Moench] viz. days to 50 % flowering, plant height, 1000-grain weight, grain yield per plant and stover yield per plant. The results obtained from the study of five crosses based on five parents and seven generations viz. P₁, P₂, F₁, F₂, F₃, BC₁ and BC₂ indicated highly significant differences between crosses (families) and between-progenies-within-family, for most of the characters. Digenic-interaction (5 or 6-parameter model) was found to be adequate for all the characters. For plant height and stover yield per plant both additive and non-additive gene effects were important however for days to 50 % flowering, 1000-grain weight and grain yield, the dominance gene effects [h] and [l] were important. Duplicate epistasis was prominently observed in all the crosses for all the traits which suggests greater effectiveness of modified selection methods like bi-parental mating, reciprocal recurrent selection as compared to single selection methods.

KEYWORDS Sorghum, gene effects, generation mean analysis

INTRODUCTION
Sorghum (Sorghum bicolor (L.) Moench) with chromosome number 2n = 2x = 20 belongs to Poaceae family. Photosynthetically, it is the most efficient C₄ plant with very high biomass production potential. With worldwide area coverage of 42.54 million ha and production of 60.06 million tonne annually, it is the fifth most important world cereal crop after wheat, rice, corn and barley. Due to inherent resiliency to climatic rigours, sorghum has potential to play an important role in the present scenario of changing climatic condition arising due to global warming and emission of greenhouse gases. Owing to assured grain and fodder yields even under low–input and receding moisture regimes, sorghum is mainstay of dryland farmers in the semi arid tropics (Anonymous 2017).

To meet the growing demand of food, feed and fodder especially in India, the prospects for expanding sorghum production largely depend on the success of research aimed at developing high yielding, dual purpose varieties and hybrids. To accomplish improvement in grain and stover yield in dual purpose sorghum, there is need to exploit genetic variance present in the population through selection as well as creation of new variability through selective recombination breeding. For selecting the most appropriate breeding methodology for holistic improvement in any crop, it is essential to study the nature and magnitude of gene action governing complex quantitative traits including yield. In the present investigation for the study of gene effect generation mean analysis was used (Hayman 1958, Jinks and Jones 1958). Generation mean analysis a first degree statistics besides being relatively simple in calculation and statistically reliable has several advantages over to second degree statistics in which variances and covariance are raw material of much of the analysis and subjected to high error variances. However, analysis of first and second degree statistics...
Estimation of genetic parameters of variability for yield and its attributing traits in CMS lines of hybrid rice

AZAD KHAN • PS SHUKLA • SA RATHER
Received: September 9, 2017, Revised: September 13, 2017, Accepted: September 13, 2017

ABSTRACT Only four rice genotypes were planted at Breeder Seed Production Centre, College of Agriculture, Pantnagar, in Randomized Block Design with three replications, during kharif - 2013 and 2014. The experiment was conducted to study quantitative traits to examine the nature and magnitude of variability, heritability and genetic advance. This study was conducted with the aim of evaluating genetic parameters in three parental lines of hybrid rice and one check. High genotypic and phenotypic coefficient of variation was exhibited by seed setting percentage, seed yield (g/m²), plant height (cm), number of spikelets panicle-¹, total spikelet test weight (g/m²), total number of spikelets panicle-¹, productive tillers plant-¹ and total tillers plant-¹. High heritability accompanied with high genetic advance was shown by plant height (cm), productive tillers plant-¹, total tillers plant-¹, number of spikelets panicle-¹, seed setting percentage, test weight and seed yield plant-¹. This indicated that these characters are governed by additive gene action and selection for these traits would be effective.

KEYWORDS GCV, genetic advance, heritability, Oryza sativa, PCV

INTRODUCTION Rice (Oryza sativa L.) is one of the oldest domesticated cereal crops which is being grown under irrigated conditions for more than 4,000 years. World wide area under rice cultivation is about 160 million ha with 744.9 million tonnes production and 4.0 tonnes/ha productivity (Anonymous 2014). Among cereals, rice occupies approximately 22.19 % of the global area. In India, rice occupies an area of 43.94 million ha with an annual production of 106.54 million tonnes and 2.42 tonnes/ha productivity (Anonymous 2015). Keeping in view the poor national productivity as compared to global productivity, Govt. of India is planning to enhance area under hybrid rice cultivation on five million ha in the next five years, in addition to enhancing the productivity level by promotion of improved hybrids and open pollinated cultivars. Present area under hybrid rice is 2.5 million ha, which accounts for 5.6% of total rice area in the country. In the last six decades, rice production has steadily kept pace with the population growth rate, mainly due to gains derived from the technologies of the green revolution era. Rice, besides being the staple food for majority of the Indian population, has also become an item of commerce during the last two decades. It helped to achieve self-sufficiency and enabling India to become a rice exporting country. India has become the largest global rice exporter. Keeping in view the annual average population growth rate of 1.8 % and estimated per capita consumption of about 250 g of rice per day, the demand for rice is projected to be around 130 million tonnes by 2025 (Prasad et al. 2014).

To sustain present food self-sufficiency and to meet future requirements in India, there is a dire need to increase rice productivity by 3 % per annum. The task is quite challenging, but the options available are limited. Amongst the available genetic options, increasing yield by exploitation of heterosis is very
Effect of time of softwood grafting and source of scion on biochemical parameters and final survival of guava grafts

ANJANA KHOLIA ● SG BHARAD ● KUNTAL SATKAR
Received: June 17, 2017, Revised: October 10, 2017, Accepted: October 22, 2017

ABSTRACT The present investigation was carried out at Propagation Unit, Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), India during 2014-15. Three different source of scion from guava varieties, L-49, Lalit and Shweta were grafted at fortnight interval from January to February. Biochemical parameters viz., total chlorophyll, chlorophyll a and b, leaf carotenoid content, leaf ascorbic acid and phenol content were studied. The maximum total chlorophyll and chlorophyll a and b was obtained from T1S3 (1st fortnight of February + Shweta). Leaf carotenoid content and ascorbic acid found maximum from T4S3 (2nd fortnight of February + Shweta) and T2S3 (2nd fortnight of January + Shweta) respectively. Treatment combination T1S1 (1st fortnight of January + Shweta) and T4S1 (2nd fortnight of February + Shweta) shows the maximum final survival of grafts. The result of present investigation illustrated that there was significant effect of time of softwood grafting and source of scion on biochemical parameters and final survival of guava grafts.

KEYWORDS Biochemical parameters, final survival, guava, softwood grafting, scion

INTRODUCTION
Guava (Psidium guajava L.) is an important tropical fruit crop and can be grown in a wide range of climatic conditions. The rising demand of guava fruits in market resulted into expansion of area under its cultivation which is coupled with an emerging high density planting (HDP) techniques. Farmers are adopting HDP rapidly due to its promising yield potential and other benefits viz., reduced cost of production, ease in intercultural operation and harvesting. All these things resulted in increasing demand of quality planting material of guava. Therefore, a rapid multiplication method is required which can fulfill the huge demand of planting material both for expanding area under cultivation and HDP in guava. The traditional methods of guava propagation are tedious, slow and produce less number of propagules. Success of propagation method like softwood grafting depends on several factors out of which time of grafting and compatibility of scion variety are major factors. The time of grafting plays a crucial role on which the final survival of grafts depends. It was reported that maximum survival of grafts was obtained in guava when grafting operation was performed on 15th February under Faizabad conditions (Beer et al. 2013). Also the appropriate scion highly suitable for grafting is also important for the final survival of grafts and it was observed that scion of guava varieties Allahabad Safeda and L-49 gave the maximum survival on grafting under Varanasi conditions (Syamal et al. 2012). Besides this, biochemical parameters also play crucial role in plant growth. The ability of crop plants to acclimatize into different environments is directly or indirectly associated with their capability to acclimate at the level of photosynthesis, that in turn affects biochemical and physiological processes and, consequently, the growth and yield of the whole plant.
Comparative performance of some pear cultivars on southern aspect of wet temperate zone in Western Himalaya

NC SHARMA • JS CHANDEL • CL SHARMA • PRAMOD KUMAR
Received: September 14, 2017, Revised: October 9, 2017, Accepted: October 22, 2017

ABSTRACT The studies were conducted at experimental farm of Temperate Horticultural Research Station, Kotkhai to compare the performance of 12 pear cultivars for their fruit quality and leaf nutritional status. Various cultivars under study differed significantly with respect to their fruit physico-chemical characteristics and leaf nutrient contents. Cultivar Red Bartlett had highest fruit length (82.37 mm), whereas, fruit diameter (76.65 mm) and fruit weight (193.50 g) were recorded significantly higher in cultivar Max Red Bartlett. Cultivar Starking Delicious exhibited highest total soluble solids (16.05 °Brix), TSS/acid ratio (66.27) and minimum titratable acidity (0.28 %). The highest fruit firmness (15.40 lbs/inch²) was recorded in cv. Beurre Hardy, whereas significantly higher total sugars content (5.95 %) and reducing sugars content (5.03) were registered by Doyenne du Comice and Kala Hathi, respectively. The cultivars Aval Number, Max Red Bartlett and Flemish Beauty exhibited highest leaf nitrogen (2.31 %), phosphorus (0.212 %) and potassium (1.96 %) contents, respectively. On the basis of fruit physico-chemical characteristics, Red Bartlett, Max Red Bartlett, Starking Delicious, Doyenne du Comice and Beurre Hardy were found suitable for cultivation in zone III of Himachal Pradesh.

INTRODUCTION
Pear is one of the most important fruit crops of temperate regions of the world. In India, it is next to apple in importance and varietal diversity among temperate fruits. This crop has wider climatic adaptability compared to apple and can do better in entire temperate region in North Western Himalayan region of the country. It is an important crop for diversification in temperate zone as its plants can succeed in areas where apple fails and can be a supportive crop in areas where apple is a predominating crop. In Himachal Pradesh the crop is being cultivated in on 6977 ha area with an annual production of 32039 tonnes (Anonymous 2016).

In existing orchards, consolidated plantations of pear are rarely seen and its orchards are found as scattered plantations in and around apple orchards. Pear cultivation remained limited due to lack of suitable commercial cultivars (Sharma et al. 2002). The other factors associated with its low acreage or scattered plantations could be poor marketing, low returns and poor shelf life in comparison to apple. The pears are now fetching remunerative prices in the market and its plantations are also gaining popularity but still there is lack of information with respect to suitability of different cultivars for different agro-climatic zones. Keeping in view the above facts, present studies were carried out to assess the performance of different pear cultivars on southern aspect of Wet Temperate High Hills Zone (Zone III) of Himachal Pradesh to find out the suitable cultivars for the region.

MATERIALS AND METHODS
The study was conducted at experimental farm of Temperate Horticultural Research Station, Kotkhai for two years during 2011-12 and 2012-13. The experimental farm is situated at an elevation of 1805 m
Effect of gamma irradiation on cyto-morphology, total phenolic content and antioxidant activity of calendula

RAJDEEP KAUR • MANISH KAPOOR • RUPINDER KAUR • AJIT KUMAR
Received: June 21, 2017, Revised: September 22, 2017, Accepted: September 23, 2017

ABSTRACT Gamma ray irradiation is one of the best ways to induce mutation and increase genetic variability in plants. The present investigation was carried out to study the effect of gamma irradiation on cyto-morphological and phytochemical attributes in Calendula officinalis Linn and screening of novel mutants. The seeds of Calendula officinalis var. Fiesta Gitana Yellow were exposed to gamma rays (20, 40, 60, 80, 100, 120 and 140 Gy) treatment using $^{60}$Co source, and un-irradiated seeds were used as control. Low doses of gamma irradiation resulted in hormesis and induced encouraging novelties, while the higher doses induced higher degree of abnormalities, which even led to mortality in many plants. In M$_1$ generation, 10 mutants were screened and tagged, of which three promising mutants viz. C$_1$ and C$_2$ at 20 Gy and C$_3$ at 40 Gy gamma irradiation, were found stable till M$_2$ generation. They were screened for cyto-morphological studies, phytochemical attributes (total phenolic content and antioxidant activity) and possible use of these novel traits (flower colour and plant height) as ornamental novelties, which can be released as a new variety after subsequent studies in further generations.

KEY WORDS Calendula officinalis, gamma irradiation, mutant, total phenolic content, antioxidant activity

INTRODUCTION Calendula officinalis Linn, commonly called pot marigold is a medicinally as well as an aesthetically important plant. The genus Calendula comprises of about 20 species of annual or perennial, herbaceous plants, native to area from Macaronesia East through the Mediterranean region to Iran (Mohammad and Kashani 2012). It got its name from Latin word “Kalendae”, meaning first day of the month because it blooms in a month after planting.

C. officinalis has been used since ages due to its rich ethno-medicinal importance. It’s yellow to orange coloured flowers are utilized as a source of essential oil for medicinal treatments and as a natural dye. It comprises of various active components like saponins, triterpendi esters and flavonoids (Hamad et al. 2011). It has also been proclaimed to own many pharmacological activities that include anti-septic, anti-inflammatory, cicatrizing, anti-viral and anti-fungal (Bogdanova et al. 1970, Kasiram et al. 2000, Khalid and Silva 2012). The ethanol, butanol and water extracts of calendula have also been revealed for their antioxidant activity (Popovic et al. 1999).

Mutation induction has become a proven way of generating alterations within a crop variety. It offers the opportunity of procuring desired attributes that either cannot be expressed in nature or have disappeared during progression. Induced mutations with gamma irradiation and chemical mutagens in ornamental plants had been used for creating genetic variations for ornamental characters. Reduction in chromosome number with increasing dose of gamma irradiation ($^{60}$Co gamma rays at 5, 10 and 20 kR) in young plants of chrysanthemum cv. Yellow Delware and Delware was observed (Ichikawa et al. 1970). Effect of mutation induction by ion beam irradiation on axillary buds in rose was investigated (Yamaguchi et al. 2003). Mutagenesis programs on calendula using...
Physico-chemical characteristics and people’s perception on usage of chuirri (*Diploknema butyraceae*)

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Received: July 22, 2017, Revised: October 14, 2017, Accepted: October 22, 2017

**ABSTRACT** Sikkim is rich in biological diversity, in particular for underutilized edible fruits. Underutilized fruits play an important role in human health, socially and economically in rural areas. One of the most prominent underutilized fruit of Sikkim is chuirri (*Diploknema butyraceae*). It is a multipurpose tree with immense value as its every part is used for different purpose. A detailed demographic field survey was conducted through semi structured interviews where the selection of a locality was done on the basis of the availability and usage of fruits. Physico-chemical characteristics of chuirri were also evaluated by collecting various samples from different locations of West Sikkim. The result showed that the content of TSS, sugars, ascorbic acid were almost at par in all the fruits that were taken from different locality. The oil estimated from pulp ranged between 1.15 - 1.51 %, total chlorophyll content ranged between 0.12 - 0.16 mg/100g, protein content ranged between 9.16 - 9.55 % and total carotenoids 1.41-3.00 mg/100g.

**KEYWORDS** Chuirri, physico-chemical characteristics, underutilized fruit, demography, protein, fats

**INTRODUCTION**

Sikkim is a small state which lies in the Eastern Himalayas, and is a very important area for plant genetic resources. Sikkim is rich in biological diversity, in particular for underutilized fruits. Underutilized fruits not only play an important role in human health but also help to raise the income of rural areas. Many wild edible fruit species are found in the Sikkim Himalayas which are cheap and easily available with vibrant taste appeal along with nutritional, medicinal, therapeutic and industrial values (Rai et al. 2005). *Diploknema butyraceae* (commonly known as chuirri) is the multipurpose species which has social, economical and environmental importance. It is also suitable for reclamation of these wastelands. Production of *D. butyraceae* oil can be a viable for livelihood option for the local farmers. The fruit yields per tree are also comparable to those of the commercial fruit species (Sundriyal and Sundriyal 2003). Its flowering time is in the month of December to February and the fruits are available during May–July.

Chuirri fruit plays an important role in natural habitats. It is rich in sugars and other nutrients (Sundriyal and Sundriyal 2003). In this context, the principle objective is to study people’s perception on its usage and its physico-chemical characteristics.

**MATERIALS AND METHODS**

The samples of chuirri fruits were collected from four places of western districts of Sikkim namely, Siktam, Sombaria, Daramdin and Tikpur and were taken to the Department of Horticulture, Sikkim University in the year 2015. A detailed field survey was conducted through semi-structured interviews and interview approach. Data were collected from both primary and secondary sources. For gender it was assigned a score of 1 for male and 2 for female. The
Response of foliar application of calcium chloride and boric acid on fruit quality and leaf nutrient status of guava

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Received: July 24, 2017, Revised: December 16, 2017, Accepted: December 20, 2017

ABSTRACT The present investigation was conducted at HRC, Patharchatta, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand in the year 2015-16. The experiment was undertaken to study the effect of foliar application of calcium and boron, sprayed at different growth stages viz., at fruit set and at two weeks after fruit set of guava. The experiment was comprised of nine treatments of different combinations of calcium and boron with three replications and experiment was laid out in randomized block design. The results showed that the maximum total soluble solids, ascorbic acid, total sugars, leaf nitrogen, calcium and boron content were recorded with application of calcium chloride @ 0.4 % + boric acid @ 0.2 % while, maximum potassium content was observed with application of calcium chloride @ 0.4 % + boric acid @ 0.1 %. Pre harvest foliar application of calcium chloride and boric acid sprayed twice was an effective way for improvement of fruit quality and leaf nutrient status of guava.

KEYWORDS Guava, calcium chloride, boric acid, fruit quality, leaf nutrient

INTRODUCTION

Guava is an important fruit crop of the tropical and subtropical regions of the world. It is available throughout the year except during summer season. Guava is quite hardy and a highly remunerative crop which can be grown without much care and attention. Guava is also known as “Super Fruit” because it has high nutritive value with many health benefits. Foliar application has been universally used and established as an essential part of crop production and improvement mainly in horticultural crops. Foliar application of nutrients offer an integral means of bringing nutrients during a critical phase of restricted nutrients supply. This feeding proved itself that it is the fastest way to cure nutrient deficiency and boosting plant performance at specific stage. Apart from this, it is quite economical and idle way of escaping the problems associated with nutrient requirement and supplementing the fertilizers to the soil. Pre-harvest calcium spray is one of the most important practices of new strategies applied in the integrated fruit production systems. Fruit calcium is an important factor determining quality. Calcium as a constituent of the cell wall, plays an important role in forming cross-bridges, which influence cell wall strength and regarded as the last barrier before cell separation. The involvement of Ca in the regulation of fruit maturation and ripening processes is also well established. Further, boron (B) is an essential nutrient element and its deficiency reduces pollen germination and growth of pollen tubes, which consequently results in the development of malformed fruits, which lowers crop yield and deteriorates fruit quality. Boron foliar applications have also been applied successfully for reducing the breakdown of fruit, fruit cracking and controlling boron levels. Furthermore, leaf-nutrient analysis is the best method for diagnosing the
Evaluation of fourteen strawberry genotypes for vegetative and floral characteristics

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Received: August 24, 2017, Revised: September 29, 2017, Accepted: October 5, 2017

ABSTRACT The study was carried out at Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Fourteen strawberry cultivars were evaluated for their vegetative (plant height, plant spread, number of leaves per plant, leaf area, number of runners per plant, days to runner formation after planting and petiole length) as well as floral characteristics (opening of first flower, opening of last flower, duration of flowering and days to flowering). It was observed that cv. Chandler outperformed all other cultivars for vegetative characters such as plant height (25.23 cm), plant spread (41.60 cm), number of leaves (38) and leaf area (172.93 cm²). Maximum number of runners per plant (51.50) and petiole length (16.48 cm) were found in Chandler. The cultivar Sweet Charlie was earliest to flower and the duration of flowering was longest in ‘Chandler’ (97.08 days) and also took minimum days to flowering. All cultivars showed significant variation in opening of flower.

KEYWORDS Vegetative, floral characters, evaluation, strawberry

INTRODUCTION
Strawberry (Fragaria x ananassa) is the most fascinating, delicious, refreshing fruit belongs to the family Rosaceae and has resulted from a cross between two wild strawberries: Fragaria virginiana (Meadow strawberry) and Fragaria chiloensis (Chilean Strawberry). The cultivated strawberry is one of the most important soft fruit of the world and all the cultivated varieties are octaploid (2n = 8x = 56). Strawberry gives back returns in the shortest possible time and is highly adapted to varied agro-climatic conditions. At present, strawberry is grown in wide climatic zones, extending from temperate, Mediterranean to sub-tropical regions. In India, it is commercially grown in Mahabaleshwar (Maharashtra), Haryana, Punjab, Uttar Pradesh, Arunachal Pradesh, Jammu and Kashmir, Uttarakhand and low hills of Himachal Pradesh. In lower hills, it is grown for fruit production, while in high hills, it is commonly grown for runner or nursery plant production.

Strawberry has considerable genetic variability and precise information on cultivars performance under different agro-climatic conditions is essential before their recommendation for cultivation. Further with passage of time, demand for new cultivars does arise. Hence, the proper and systematic evaluation of germplasm would yield useful information with regard to their suitability for commercial cultivation, and through characterization build a database regarding their performance under a set of agro-climatic situation.

MATERIALS AND METHODS
To carry out the investigations on the varietal evaluation of strawberry, the planting of runners was done on raised beds (15 cm) on 1st November, 2011.
Pruning and productivity of old unproductive ber cultivars in lower Shiwaliks of Punjab

YOGESH KHOKHAR
Received: August 29, 2017, Revised: September 13, 2017, Accepted: September 15, 2017

ABSTRACT A study was conducted to rejuvenate old orchard of ber under rainfed conditions. Though the trees started fruiting in the same year after rejuvenation but the yield was negligible, although it increased remarkably during third year. The vegetative growth traits i.e. plant height, spread and canopy volume was significantly affected by severity of pruning. Plant height after three years of pruning was recorded maximum in Sanaur-2 than ZG 2 and Umran. Tree spread and canopy development of rejuvenated trees in terms of tree volume showed increase over the year of rejuvenation as age of tree increased irrespective of cultivar. The variety Sanaur-2 recorded 3.50 times higher yield compared to yield level just before the process of rejuvenation. The morphological attributes of fruits obtained from rejuvenated trees were significantly higher than non-rejuvenated trees of each cultivar. The chemical attributes, i.e. TSS and total sugars were found slightly higher in fruits from non-rejuvenated trees. Hence, rejuvenation technology helped in restoring the productivity of old, unproductive orchard in shortest possible time in lower Shiwaliks of Punjab.

KEYWORDS Ber, cultivars, rejuvenate, Sanaur-2, total sugars

INTRODUCTION

The Indian ber or jujube (Zizyphus mauritiana Lam.) is one of the most ancient cultivated fruit tree grown in North Indian plains particularly Punjab, Haryana and Rajasthan. However, over the years, ber trees start giving diminished yield and smaller fruits of inferior quality after bearing normal crops for 20-22 years. The established and healthy unproductive trees can be converted into productive ones by rejuvenation with improved and region-specific commercial cultivars. It has been observed that the tree architecture engineering, canopy density and photosynthetic efficiency play important role in governing the fruiting potential (Lal and Mishra 2008). There are several reports on rejuvenation by pruning, canopy management, dehorning and top working in different fruit crops. Rejuvenation practice with heading back of branches in mango during December at a height of 4 m from the ground level and effective after-care management can give new lease of life to the unproductive orchards for another 25-30 years and make them productive and economic after four years of rejuvenation (Lal and Mishra 2008). Similarly, in guava, yield enhancement in the range of 70-90 % over the unpruned trees can be recorded after first year of rejuvenation. Success rate of 40 – 100 % by top working on seedling aonla trees has been reported (Pathak et al. 1996). Keeping this point in view, a study was conducted to rejuvenate 29 year old orchard of ber and study its effect on growth, yield and quality under rainfed conditions of lower Shiwaliks of Punjab.

MATERIALS AND METHODS

The present investigation was carried out at Regional Research Station, Ballowal Saunkhri during 2014-16 under rainfed conditions. This centre is located in the agro-climatic Zone-I in the North-Eastern part of Punjab (agro-ecological sub-region
Performance of potato cultivars under different irrigation regimes at North-Eastern Indian Plateau

JOY K DEY • LALA IP RAY
Received: April 6, 2017, Revised: October 4, 2017, Accepted: October 22, 2017

ABSTRACT Under hilly terrain of North-Eastern India (NEI), potato based cropping system is practiced but the productivity level is much lower. Being an exhaustive crop, water saving irrigation techniques need to be adopted to maximize potato productivity, as availability of irrigation water is a great concern in the hilly region. Four potato cultivars were taken up with three different irrigation systems to study the performance efficacy. Plant growth attributes like plant height and leaf area index showed significant response under irrigation treatments, however, dry matter accumulation showed significant variation under varietal treatments. Plant growth rate parameters also exhibit significant response during the early developmental phase of the crop growth. There was a significant difference in crop yield among different cultivars. The crop yield was found highest for kufri megha (15.66 t ha\(^{-1}\)) over other three cultivars. The yield performance of Kufri Megha, Kufri Jyoti and Kufri Giriraj was found to be at par. The water use efficiency (WUE) and benefit cost ratio (BCR) was evaluated to be 14.66 kg ha\(^{-1}\) mm\(^{-1}\) and 1.85, 18.78 kg ha\(^{-1}\) mm\(^{-1}\) and 2.31 for furrow, micro-sprinkler and gravity-fed drip, respectively.

KEYWORDS Potato cultivars, irrigation methods, BCR, WUE, North East India

INTRODUCTION

Potato is the world’s fourth most important food crop with total production of 370 million t from 19 million ha of land after rice, wheat and maize (FAO 2013). India stands second as the largest potato producer in the world after China (Scot and Suaraz 2011). Potato is a sensitive crop to water stress and soil water fluctuation than other crops (Onder et al. 2005, Jabro et al. 2012). The sensitivity to water stress is most often explained by the relatively shallow root system and low root to shoot ratio, which limit its capacity to extract water and nutrients from the soil (Harris, 1992, Thiele et al. 2010). High potato production with better tuber quality was reported when the availability of water is optimum with minimum variation in soil moisture content in the edaphic zone (Alva et al. 2012). North Eastern India (NEI) enjoys various agro-climatic zones favouring potato cultivation, however, assuring irrigation water is a major concern during non-rainy seasons. In the hilly states of NEI, potato is grown in an area of 18,173 ha, producing 1,81,089 tonnes with an average yield of 9.9 t ha\(^{-1}\), which is much lower as compared to all India average of 22.72 t ha\(^{-1}\) (Saxena and Mathur 2013). Under these scenarios, an agronomic trial has been conducted to evaluate the performance of four different potato cultivars with three different irrigation methods under Meghalayan plateau of NEI.

MATERIALS AND METHODS

A field experiment was conducted during winter 2015-16 at the experimental farm of the College of Postgraduate Studies, Barapani (CAU, Imphal), to evaluate the comparative yielding capacity of the four different potato cultivars under three different irrigation methods. The experiment was laid out in split plot experimental design with three main plot treatments, viz., Furrow irrigation (I\(_1\)), Micro-sprinkler
Antioxidant properties variation in radiation induced genotypes of jatropha

DILESWAR NAYAK ● NIVRUTI S PATIL ● LK BEHERA ● NITESH S LITORIYA
Received: June 29, 2017, Revised: September 16, 2017, Accepted: September 20, 2017

ABSTRACT Jatropha curcas L. produces seed oil believed to have immense potential as an economical alternative for diesel fuel. This study was undertaken to evaluate effect of gamma rays with rate of 10, 20 and 30 kR on biochemical characteristics of leaves among seven genotypes. Result showed that Chhatrapati genotype performed better for various biochemical properties such as total soluble sugar, protein, free amino acid, total phenol content and moisture content than other genotypes. However, guaiacol peroxidase activity was found to be higher in Hansot genotype. Maximum superoxide dismutase activity was recorded in SKN Big genotype. The increase in gamma rays irradiation progressively increases total soluble sugar, protein, free amino acid, total phenol content, superoxide dismutase (SOD) and guaiacol peroxidase (GPOX). The interaction effect of genotypes and gamma rays treatment were found to be significant for GPOX activity. The significantly highest GPOX activity was recorded under Chhatrapati genotype at 30 kR irradiation. However, the interaction effect of genotype and gamma rays treatment of other biochemical traits like total soluble sugar, protein, free amino acid, total phenol content and moisture content were non-significant during field growth stage.

KEYWORDS Gamma ray, antioxidants, enzyme activity, genotype, Jatropha curcas L.

INTRODUCTION

Exposure of living organisms to ionizing and non-ionizing irradiation constitutes a major exogenous source of reactive oxygen species (ROS). Specially, gamma rays irradiation produces a whole range of radical and non-radical species from ionization of intracellular water (e.g. aqueous electron, OH, H₂O₂). The generation of ROS, such as the superoxide anion (O₂⁻) and hydrogen peroxide (H₂O₂) can cause lipid peroxidation with membrane destruction, protein inactivation or DNA mutation (Garmendia et al. 2004). However, the degree of damage is alleviated by the presence of enzyme defense systems such as superoxide dismutase (SOD), guaiacol peroxidase (GPOX) and other enzymes. Among these, activities of enzymatic antioxidants are important during development of plants and stress condition due to their role in prevention of fatty acid chain oxidation by removal of O₂⁻ and H₂O₂. Peroxidases, besides their main function in elimination, can also catalyze super oxide radical (O₂⁻) and hydrogen peroxide (H₂O₂) formation by a complex reaction in which NADH is oxidized using trace amounts of H₂O₂ first produced by the non-enzymatic breakdown of NADH. Next, the NAD radical formed reduces O₂⁻ to O₂, some of which dismutates to H₂O₂ and O₂ (Lamb and Dixon 1997). Thus, peroxidases and catalases play an important role in the fine regulation of ROS concentration in the cell through activation and deactivation of H₂O₂ (Blokhina et al. 2003). Again, leaf water is most commonly related leaf physiology like leaf turgor, stomatal conductance, transpiration, photosynthesis and respiration (Kramer and Boyer 1995). Simple phenolics and flavonoids show a wide range of antioxidant activities in vitro (Rice-Evans et al. 1997) and are thought to exert protective effects against major plant stress. Furthermore, amino acids are involved in stress responses such as scavenging of...
Effect of plant architecture on seed yield and quality of radish

SHAGUN • DK MEHTA • RAMESH KUMAR • ROHIT VERMA
Received: July 13, 2017, Revised: October 7, 2017, Accepted: October 22, 2017

ABSTRACT The present investigation was carried out in radish cv Japanese White in Randomized Complete Block Design with 18 treatments viz., control (T1), topping of flower stalk at initiation (T2), steckling dip of PBZ @ 10, 20, 30 and 50 ppm at replanting (T3 to T6), foliar application of PBZ @ 25, 50, 100 and 200 ppm at flower stalk emergence (T7 to T10), steckling dip of Pro-cal @ 10, 20, 30 and 50 ppm at replanting (T11 to T14) and foliar application of Pro-cal @ 25, 50, 100 and 200 ppm at flower stalk emergence (T15 to T18) with three replications of each treatment. Analysis of variance showed significant differences among the treatment combinations for all the characters studied except duration of flowering and days to harvesting. Experimental results revealed that treatment T6 i.e. steckling dip of PBZ @ 50 ppm at the time of replanting was found superior over all other treatments in terms of growth, seed yield and seed quality characters and there was an increase of 27.86% in seed yield over the control.

KEYWORDS Plant architecture, paclobutrazol (PBZ), prohexadione calcium (Pro-cal), seed yield, seed quality, radish

INTRODUCTION
Radish (Raphanus sativus L.) is an important root vegetable grown both in tropical and temperate regions of the world. It is a diploid plant (2n = 2x = 18) belonging to family Cruciferae. Radish is a cool season crop and divided in two groups, viz. Asiatic or Tropical and European or Temperate types. The Asiatic types produce roots and seeds both under tropical and temperate climate while European types produce roots under both climatic conditions but its seeds can only be produced in hills or temperate climate. The advantage of the prevalence of both types of climatic conditions has been thoroughly exploited by the state of Himachal Pradesh for year round production of radish.

One of major problem in seed production of radish is lodging due to excessive growth of plants resulting in poor seed yield and also reduces the quality of seeds. It is often a result of the combined effects of inadequate standing power of the crop and adverse weather conditions, such as rain, wind, and or hail. In addition, increased plant densities, shading and high moisture content, especially under cloudy and humid conditions, have been found to increase the tendency of the plants to lodge. So, it is important to prevent lodging in order to avoid the problem of poor seed yield and seed quality.

A small change in plant architecture can have a strong influence on lodging of a plant. Plant architecture refers to the three dimensional organization of plant body. It includes branching pattern, size and number of leaves, internodal distance, flowering, etc. (Reinhart and Kuhlemeier 2002). In the present study, the focus was on topping of seed stalk at emergence and use of growth retardants like paclobutrazol (PBZ) and prohexadione calcium (Pro-cal), which were involved in the modification of plant architecture leading to reduction in lodging.
Sources of resistance in *Brassica juncea* lines against *Albugo candida*

KALPANA GAIROLA • AK TEWARI • RAM BHAJAN • U PANT

Received: May 16, 2017, Revised: July 8, 2017, Accepted: August 10, 2017

**ABSTRACT** A series of PWR (Pant-white rust), PAB (Pant-Alternaria Blight) and PRD (Pant-Rai Disease) *B. juncea* lines were screened under field (epiphytotic) conditions and glasshouse conditions at cotyledonal and true leaf stage for confirmation of resistance against *Albugo candida* (white rust disease). In field all PWR lines were found immune, however, among PRD lines, 23 lines were moderately resistant and 6 were moderately susceptible, among PAB lines, 16 lines were moderately resistant and 11 were susceptible against white rust disease at 90 days after sowing. All the PWR, PRD and PAB lines were further tested in glasshouse, at cotyledonal and true leaf stage for confirmation. The PWR lines which were free from the disease at field conditions at cotyledonal leaf stage only showed immune reaction and six showed resistant reactions. However, at true leaf stage none of the lines showed immune reaction, 01 line showed highly resistant reaction and 03 lines showed resistant reactions. Present study revealed that the glass house study is more appropriate method for screening of resistance against white rust as actual resistance is obtained. Earlier cotyledonal stage was recommended for the confirmation of the resistant sources however, the present findings revealed that in glasshouse, true leaf stage is most important for the confirmation.

**KEYWORDS** *Albugo candida*, cotyledonal, phenotypic disease reaction, resistance

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**INTRODUCTION**

Indian mustard (*Brassica juncea* L.) is an important oilseed crop of India. It occupies 80 % of the cropped area under oilseed *Brassica* (rapeseed-mustard) and accounted about 29.2 % of national oilseed crop outputs (Nashaat et al. 2007). *Albugo candida* (Pers. Ex. Lev.) Kuntze is an obligate parasite causing white rust disease in many cruciferous crops (Saharan and Verma 1992). The pathogen causes both local and systemic infection. Local infection as white or creamy pustules or "blisters" on leaves and stems and systemic infection of meristems and inflorescence, gives rise to malformed inflorescence (racemes) called stag head (Petrie 1973). In India, the disease causes 20-60 % loss in annual yield of mustard. Differential level of host resistance has been identified from *Brassica juncea* genotypes against some Indian, Canadian, Chinese and Australian isolates of *A. candida* (Townsend et al. 2003, Li et al. 2008). In India, the main focus for identification of resistant sources is field level testing. It is appropriate method but needs confirmation as some times, disease escapes due to low disease pressure as well as due to some other reasons. Considering these problems, present investigation was undertaken for confirmation of resistant sources in *B. juncea* against *A. candida*.

**MATERIALS AND METHODS**

PWR (14 No.), PRD (29 No.) and PAB (27 No.) collected from Department of Genetics and Plant Breeding, GB Pant University of Agriculture and Technology, Pantnagar were used for identification of resistant sources against white rust. PWR lines are the segregated materials selected from GP-11-222 a local *B. juncea* material from village-Van, Block-Dewal, District Almora, which showed resistance against white rust disease under field conditions (2011-2014). The PAB and PRD lines were developed by crossing. These have good agronomic background (Kranti, Varuna and Pusa bold) with disease resistance traits.
Screening for bacterial wilt resistance of bell pepper under sick field conditions and morphological characterization

SONIA SOOD • MINAKSHI THAKUR
Received: June 22, 2017, Revised: October 9, 2017, Accepted: October 15, 2017

ABSTRACT The present investigation was carried out on 46 genotypes of bell pepper to study bacterial wilt resistant genotypes and their morphological characterization under natural sick field conditions at Palampur aiming at the development of high-yielding, bacterial wilt (Ralstonia solanacearum) resistant lines of bell pepper. Based upon the mean performance, genotypes DPCBWR-14-39, DPCBWR-14-36, DPCBWR-14-31, DPCBWR-14-35, DPCBWR-14-11, DPCBWR-14-7 and DPCBWR-14-29 were found to be top yielders and resistant to bacterial wilt disease. All the genotypes taken for study were found to be resistant and moderately resistant to bacterial wilt disease except DPCBWR-14-22, DPCBWR-14-23, DPCBWR-14-34, DPCBWR-14-37 and DPCBWR-14-43. Bell pepper germplasm contained sufficient genetic variability and can be used for crop improvement. Coincidently, among the top five high yielding progenies most showed green group (GG), blocky fruit shape, pendent fruit position, cordate fruit shape at pedicel end and sunken fruit shape at blossom end. Thus, these genotypes can be further used for breeding programmes and can be directly used after multi-location testing as these possess inherent ability to high yielding alongwith bacterial wilt resistance.

KEYWORDS Bell pepper, bacterial wilt, resistance, characterization, colour, descriptor

INTRODUCTION
Bell pepper (Capsicum annuum L. var. grossum Sendt.), 2n = 24, commonly known as sweet pepper or capsicum or Shimla mirch, a low volume and high value vegetable, is one of the most potential off-season vegetables of mid hills of Himachal Pradesh. Bell pepper is extensively grown during summer-rainy season in hills. The summer-rainy season crop grown in lower and mid-hill pockets of the North-Western hills fetches high prices being off-season crop of the plains. However, the yield potential and total production of bell pepper in the state is low due to poor yielding varieties and its susceptibility to numerous foliar, fruit and root pathogens that reduce yield and quality. Among diseases, bacterial wilt caused by Ralstonia solanacearum (syn. Pseudomonas solanacearum) is most severe disease of bell pepper in humid tropical and sub-tropical climates with high rainfall and warm weather (Cerkauskas 2004, Elphinstone 2005). Bacterial wilt disease is very severe in hot and humid tropics, sub-tropics and sub-tropical areas when the weather is wet and temperature (day) is between 30-35 °C. This disease seems to be a major hurdle in commercial cultivation of this crop and assumed an alarming proportion in some specific pockets of zone-I and zone-II of Himachal Pradesh. Another major concern is that bacterial wilt is further spreading to other districts like Bilaspur and Hamirpur of Himachal Pradesh.

Further, bacterial wilt is also an important disease to be recorded in other states like Karnataka, Kerala, Maharashtra, Odisha, Bihar, Sikkim, West Bengal and Andaman and Nicobar Islands. Yield losses up to 100 per cent have been reported in wilt prone areas of the world (Wang et al. 1997). The available varieties of bell pepper in Himachal Pradesh are highly susceptible to bacterial wilt. Ironically, none of the measures are effective, neither the chemical control measures nor the high yielding varieties are resistant to this disease.
Edible mushroom cultivation for rural development in Himachal Pradesh

DIVYA SHARMA • VIRENDER KUMAR
Received: July 25, 2017, Revised: September 20, 2017, Accepted: September 25, 2017

ABSTRACT Commercial production of mushrooms represents unique exploitation of the microbial technology for the bio conservation of the agricultural, industrial, forestry and horticultural wastes into nutritious food. Mandi district was purposively selected for the study due to sufficient number of mushroom growers in the district. A sample of 60 growers was selected by proportional allocation method. For the selection of the sample two stage random sampling technique was adopted. The overall net returns per rupee of investment were more for large growers i.e. Rs 1.27. In order to understand the determinants of mushroom production, regression analysis was done using Cobb-Douglas production function. Three channels of marketing were followed by the growers in the study area but the (producer → retailer → consumer) was the most important and followed by 56.06 % of growers through which 44.09 % of mushroom produce was marketed. On overall farms, marketed surplus was 78.67 % which varied from 56.96 % on small farms to 86.38 % on the large farms.

KEYWORDS Net returns, benefit-cost ratio, marketing channels, marketed surplus

INTRODUCTION
The fact that India is blessed with varied agro-climatic conditions, abundant agricultural wastes and sufficient manpower, make it all the more suitable for the cultivation of all types of temperate, subtropical and tropical mushrooms across the length and breadth of the country. At present, India generates about 700 million tonnes of agricultural residues and a large amount of it is either burnt or left in the field for natural decomposition. At present, only about 0.03% of these residues are being used for producing mushrooms. Utilization of agro-residues for mushroom production will not only help to reduce the environmental pollution but will profitably recycle them into quality food, besides improving soil health due to recycling of spent mushroom substrate (Sharma et al. 2010). Though mushroom production in India started in 1960s, it was during 1990s that there was sudden jump in mushroom production due to hi-tech projects set up in collaboration with the foreign partners. This resulted in significant increase in mushroom production from 4,000 tonnes (1985) to 38,000 tonnes (1997) and at present it is estimated to be around 1.2 lakh tonnes per annum (Thakur 2014). A major share (80 %) is contributed by the button mushroom though specialty mushrooms have greater scope in the country. Mushroom growing is mainly confined to Punjab, Uttarakhand, Haryana, Uttar Pradesh, Tamil Nadu, Himachal Pradesh and Maharashtra. With this background, the present study seeks to examine the status of mushroom cultivation across the country along with the economics of mushroom production in Himachal Pradesh.

MATERIALS AND METHODS
The study is based both on the primary as well as secondary data. The status of mushroom cultivation in the country has been examined using the secondary
Forest based livelihood pattern of tribal communities in Assam, India

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Received: August 6, 2017, Revised: September 28, 2017, Accepted: October 10, 2017

ABSTRACT This study was conducted in Karbi Anglong and Dima Hasao districts of Assam to evaluate role of forest resources including non-timber forest products (NTFP) on livelihood of people. Results revealed that dependant villagers got benefits from community resources, i.e. staple food from jhum (shifting) or other forms of cultivation, NTFP (fruits, leaves and vegetables), small timber and medicinal herbs etc. Collection of various forest products in terms of minor and major forest products from various community forest areas as well as from some reserved forest area indicates the importance of forest based livelihood in the districts. Total average annual collection per household recorded as Rs. 15,560/- from different major forest products among the beneficiaries of NERCORMP and the highest from timber. So far NTFP, annual average collection recorded at Rs. 13,252/- per household and bamboo contributed the maximum percentage (33.4%). Cultivated and value added forest products also contributed a section of their income annually among the beneficiaries. Whereas, non-beneficiaries were seen a bit reluctant to come forward for management of their resources. Thus forest resources were seen utilised in various ways for their livelihood management in the study area.

KEYWORDS Forest, non-timber forest products, NERCORMP, livelihood, communities, Assam

INTRODUCTION North Eastern Region Community Resource Management Project for upland areas (NERCORMP), a livelihood and rural development project funded by International Fund for Agricultural Development (IFAD) and North Eastern Council, Ministry of Development of North Eastern Region (DoNER), Government of India has appeared as a big intervention for improvement of livelihood pattern in some parts of North Eastern Region during the last part of 20th century. Originally the project was operational in six districts of three North-Eastern states since its' inception in 1999 viz. (Karbi Anglong and Dima Hasao districts (old NC Hill) from Assam; West Khasi Hills and West Garo Hills districts from Meghalaya and Senapati and Ukhrul districts from Manipur). At present, the project is in its third phase and extension of the programme has already been initiated in Arunachal Pradesh and Manipur including two new districts viz. Churachandpur and Chandel from 2014. North Eastern Region Community Resource Management Society (NERCORMS) located at Shillong, Meghalaya is working as regional office as well as the head office and every implementing district has district level society in their respective districts to run the project. The project adopts a holistic development approach with two broad focus areas - social mobilization and capacity building - to tap the potential of the communities by employing time-tested traditional value systems. The main thrust area is on income generating activities. Major activities include capacity building of communities, repairing and building of village roads, rural electrification, community-based bio-diversity conservation, natural resource management and communication, convergence with ongoing government schemes and marketing support.

NERCORMP project areas of Assam are predominant in terms of availability of forest resources.
Hypsometric analysis of Mid-Himalayan watershed using geomatics

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Received: October 13, 2017, Revised: December 26, 2017, Accepted: December 26, 2017

ABSTRACT Hypsometric analysis describes the distribution of horizontal cross-sectional area of watershed morphology with respect to elevation (area-altitude analysis). In geologic time scale youth, mature and old geologic stage represents peculiar hypsometric forms of watershed. The hypsometric analysis give picture about pertinent condition of transition from youth to old stage of watershed. Hypsometric characteristics of a watershed plays important role in the dynamics of surface and subsurface runoff generation and resulting soil erosion and denudation processes. Hypsometry is essential aid to measure and represent the form of a watershed and its evolution. Aim of the paper is to carry out the hypsometric analysis of Naula watershed, situated in mid Himalayan region of Uttarakhand using remote sensing and GIS technologies. Hypsometric data were derived and analyzed for Naula watershed from the 1 arc-second Cartosat-1 DEM. In the present study hypsometric integral was found as 0.357, which is indicative of existence of 35.7 % of original rock mass of Naula watershed.

KEYWORDS Hypsometric analysis, hypsometric Integral, GIS, Cartosat-1 DEM

INTRODUCTION

Hypsometry of a watershed can be expressed graphically as hypsometric curve and calculated as a dimensionless number as hypsometric integral (Hi). Dimensionless form of hypsometric analysis represents the overall slope and forms of drainage basins (Langebein 1947). Evaluation of different shapes of hypsometric curves by comparing different drainage basins and classification of basins according to their stages of geomorphic evolution (Fig 1) done as: youth stage (convex upward curves, where Hi ≥ 0.60), where the watershed is highly susceptible to erosion and land sliding; equilibrium or mature stage (S-shaped hypsometric curve which is concave upward at high elevations and convex downward at low elevations, where 0.30 ≤ Hi ≤ 0.60); and peneplain (concave upward curve, where Hi ≤ 0.30) or monadnock stage (Strahler 1952).

Variation in the shape of hypsometric curves exists during the early stages of geomorphic evolution, but followed by minimal variation after the drainage basins achieved equilibrium or mature stage. Hypsometric curve and hypsometric integral both have effects on erosional characteristics of watershed and can be used as indicators of the “fluvial cycle of erosion” (Strahler 1952). There exists a negative correlation between hypsometric integral (Hi) and drainage basin elevation, slope steepness, stream channel gradients and drainage density. A positive correlation is evident between the average length of stream segments of any given order in each area, and the corresponding mean hypsometric integrals, where progressive decline in stream length in the same order is evident as the integrals diminish (Strahler 1952).

Methodology to investigate lower order small drainage basins developed by (Strahler 1952, 1952b,
Impact of public and private agricultural extension on production and income of pomegranate growers

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Received: April 19, 2017, Revised: November 23, 2017, Accepted: November 25, 2017

ABSTRACT Pomegranate needs a critical care at production level and it enhances need of consultancy service for good production. Hence, there are number of private people and public servants working as consultants. The study was conducted in Hiriyuru, Hosdurga and Challakere taluk of Chitradurga districts of Karnataka, with a total sample size of 120 comprising, 60 growers each, under public extension and private extension systems. “Ex-post-facto” research design was used in the study. Hiriyuru taluk has recorded highest yield (5160 kg/acre) in case of public extension. Whereas, Challakere (6722.5 kg/acre) recorded highest yield, in case of private extension. The impact of public and private extension systems on pomegranate growers on income revealed that pomegranate growers of Hiriyuru obtained highest income of Rs. 257043.75 per acre in case of public extension system, whereas, in case of private extension Challakere pomegranate growers obtained highest income of Rs.364823.75 per acre. The benefit to cost ratio is highest in Hosadurga taluk (3.59) in private extension and in public extension the highest return was found in Hiriyuru (3.10).

KEYWORDS Pomegranate, impact, public extension service, private extension service, income, production

INTRODUCTION
Agricultural extension, traditionally, has referred to the work of a professional body of agricultural experts, often government employees, imparting improved methods of farming, demonstrating innovations and helping farmers to organize and solve their problems. Extension has also served as a link between farmers to transfer the “best practices” of one farmer to another and as a channel to introduce and sometimes enforce agricultural policies. Agricultural extension activities presently, encompass a wide range of activities (in the public, private, non-profit and non-governmental sectors), but the exchange of information continues to be the primary focus of extension activities. Extension in India has a mixed record of achievement. The literature is clear in recognizing agricultural extension as a factor in promoting productivity, increasing, sustainable resource use and more broadly, agricultural development (Singh 1999). Pomegranate is cultivated as a commercial crop because of its high income generating capacity. Pomegranate needs a critical care at the production level and it enhances the need of consultancy service for the production. Hence, there are number of private people working as consultants along with public extension personnel (Saravanan 2001). Affordability of the growers to pay is a key factor for private extension in the area. Extension service budgets may be in adequate. Issues of motivation, competence, performance and accountability of extension institutions and their agents may affect results.

In Chitradurga district, pomegranate is being grown on commercial scale over an area of 6911 ha with production of 62199 tonnes and productivity of 9000 kg/ha during 2014-15. Dry land horticulture is picking up fast in Chitradurga district, and hence, there is a lot of scope for increasing production, productivity.
Effect of pre-harvest calcium chloride spray on maturity and postharvest quality of Starkspur Golden Delicious apple

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Received: July 24, 2017, Revised: September 21, 2017, Accepted: September 22, 2017

ABSTRACT The study was conducted to establish harvest maturity to enhance postharvest quality and shelf-life of fruits by pre-harvest spray of calcium chloride after 60 days from full bloom (DFFB) in plants of Starkspur Golden Delicious apple. Harvesting of fruits was conducted in three stages, at 5 days intervals from experimental plants. The fruits were evaluated for quality attributes during different storage intervals. It was observed that fruits with calcium chloride (0.75 and 1 %) were smaller in size but exhibited more firmness at harvest maturity. Physiological loss in weight (PLW) and soluble solids concentration (SSC) of fruits increased and firmness decreased continuously at different storage intervals. Less PLW and high firmness was observed in calcium sprayed fruits during shelf-life studies of 42 days. SSC increased with increase in storage interval and remained at an acceptable level up to 42 days in calcium sprayed fruits. Fruits sprayed with 1 % calcium chloride had significantly high firmness and low PLW during this study. Therefore CaCl₂ (1 %) spray at 60 DFFB is recommended for enhancing shelf life of apple fruits.

KEYWORDS Starkspur Golden Delicious apple, pre-harvest sprays, harvest maturity, days from full bloom, quality, shelf-life

INTRODUCTION
Apple (Malus × domestica Borkh) is an important temperate fruit of the world. In India, commercial cultivation of apple is largely confined to Jammu and Kashmir, Himachal Pradesh and Uttarakhand, producing 24,97,680 tonnes (Anonymous 2014). Apple, a principal horticultural crop of Himachal Pradesh and mainstay of the state’s economy, is being grown in 1,01,485 ha with production of about 8 lakh tonnes (Kanwar 2015). Himachal Pradesh State Horticulture Department has observed a bumper apple production of over 3.75 crore apple boxes (20 kg each) during 2013 (Anonymous 2013). Apple fruits are harvested from August to October in Himachal Pradesh (Krishnaprakash et al. 1988, Barwal 1995). During peak harvesting period, markets get flooded with apples which crash the prices of fruits and consequently farmers do not get good returns of their produce. Fruit ripening is a biological process involving respiration and enzymatic activities which deteriorate the quality during prolonged marketing period. Thereby, the proverb “An apple a day keeps the doctor away” addressing health benefits of the fruits does not hold true to the consumers. Moreover, consumers increasingly demand high quality, crunchy and crispy apples (Matzinger and Tong 2013). Calcium as a constituent of the cell wall plays an important role in extending shelf-life of many fruits by maintaining firmness, minimizing respiration and tissue breakdown (Klein et al. 1997, Bhat et al. 2011, Shirzad et al. 2011). Increase in calcium generally delays the ripening of the apple fruits, maintains their quality during prolonged storage and also reduces the incidence of storage decay (Conway 1982). Several physiological disorders and diseases of apple fruits during storage are related to the calcium content of fruits and its deficiency results in economic losses.
Development of enriched fibre bites from composite flour

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Received: August 8, 2017, Revised: September 10, 2017, Accepted: September 12, 2017

ABSTRACT The present investigation was carried out with an objective of developing nutritious quality bites containing enriched fibre and low gluten by replacing refined wheat flour with rice, pearl millet and okara flours. Box-Behnken Design as per the Response Surface Methodology (RSM) was employed to optimize levels of different flours obtained from wheat, rice, pearl millet and okara from soybean. RSM optimized levels of maida, okara, rice and pearl millet flours to prepare quality bites were 54.9, 39.1, 3 and 3 %, respectively. Ratings for all the sensory attributes of bites were statistically (P ≤ 0.05) higher than those of control bites prepared only from maida. Bites produced from composite flour had about 10 times more fibre and calcium as compared to control bites. There was no significant effect of storage on the sensory quality of bites packed in polyethylene bags during storage for six weeks. The developed product owing to its high fibre and calcium content but low gluten and reasonable shelf life might be preferred much by the consumers and hence may be expected to have great marketing potential.

KEYWORDS Bites, okara, pearl millet, rice, fibre

INTRODUCTION
Bite or namkeen para is an Indian traditional deep fat fried snack food popular throughout the country. Traditionally, it is prepared from refined wheat flour (maida) with incorporation of common salt, spices and fat. Bite is a very simple and easy to make tea-time snack item. It is ribbon-like strip of pastry which is delicately seasoned with cumin or caraway seeds and deep fried in pure ghee. They are crispy yet puffy salted strips of dough that are deep fried. Most snack foods being cereal based are either poor sources of protein or contain proteins of poor nutritional quality. The quality of the protein in such products could be substantially improved through blending of the cereal component with legumes and other grains. The judicious blending of okara, rice, pearl millet and refined wheat flour may produce delicious and nutritious bite.

RSM is a useful statistical tool applied in process optimization. Experimental conditions that optimize a process response as a specific characteristic of quality of the final product can be obtained by this method. It allows finding an optimal experimental condition that meets all the process responses established as ideal. The use of RSM offers several advantages as it is possible to combine the results obtained from properties measured on different orders of magnitude, the transformation of different responses to one measurement is simple, objective and quick, both qualitative and quantitative responses can be used, it is clearly defined what results are acceptable for each individual response and what values would not be acceptable (Eren and Kaymak-Ertekin 2007).

The purpose of this work was to develop enriched fibre bites with optimum mixing of okara, rice, pearl
Effect of various pre-harvest treatments on storage quality of peach cv. July Elberta

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Received: October 12, 2017, Revised: October 27, 2017, Accepted: October 30, 2017

ABSTRACT The study was undertaken to assess the effect of various pre-harvest treatments (calcium chloride, paclobutrazol and cycocel) on storage quality of peach cv. July Elberta. The trees were maintained under a uniform schedule of cultural operations throughout the season and subjected to preharvest treatments of various chemicals like calcium chloride, paclobutrazol and cycocel at three different concentrations applied at 6 and 7 weeks after flowering. Among all the pre-harvest treatments, T3 (1.0 % CaCl₂) treatment overall has shown that besides reducing physiological weight loss (PLW) and spoilage, it also effectively retained firmness, titratable acidity, ascorbic acid and pectin content, while, at the same time these treatments were also effective in reducing the rate of respiratory and enzymatic activity. Out of the 13 treatments, T3 (1.0 % CaCl₂) proved to be most effective however, it was at par with T6 (300 ppm paclobutrazol) and T2 (0.75 % CaCl₂) and the study concludes that CaCl₂ preharvest application has a beneficial effect on extending the shelf life of peach fruits.

KEYWORDS Peach, pre-harvest treatment, calcium chloride, paclobutrazol, cycocel, storage quality

INTRODUCTION
Peach (Prunus persica L. Batch) is an important stone fruit grown under temperate and sub-tropical climate. In India, peach cultivation extends from Northern plains to an elevation of 2000 metres above mean sea level occupying an area of about 18,500 ha with an annual production of 1,50,000 MT (Soodan et al. 1994, NHB 2014). It is commercially grown in states of Arunachal Pradesh, Haryana, Himachal Pradesh, Jammu and Kashmir, Nagaland, Punjab, Uttarakhand and Uttar Pradesh. However, in Himachal Pradesh peach is cultivated commercially in an approximate area of 4800 ha, which is scattered all over the state except the dry and cold regions of Lahaul and Spiti, Kinnaur, Pangi and Bharour areas of Chamba district, with an annual production of about 6564 MT (Anonymous 2014). July Elberta is the largest propagated commercial cultivar grown in Himachal Pradesh due to its high yield and good market value.

Peaches like other stone fruits cannot endure long storage life at normal atmosphere and ambient temperature after harvest as the fruit tends to soften, thereby, resulting in textural breakdown in postharvest period of handling and transportation. The losses in stone fruits may be higher as these are highly deteriorative in nature. Peaches exhibit considerable deterioration in quality after harvest due to rapid physiological changes which continue to occur in the fruit during marketing and storage. Further, the harvest season coincides with peak summers or early monsoon, which favours the growth and multiplication of spoilage causing organisms which ultimately results in lowering the fruit quality and life as well as consumer acceptability thereby tending to cause a huge economical loss to the growers. These
Changes in quality attributes during storage of underutilized green leafy vegetables

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Received: June 10, 2017, Revised: September 29, 2017, Accepted: October 10, 2017

ABSTRACT Present investigation was undertaken to extend the postharvest life of local underutilized green leafy vegetables by using convenient and affordable consumer size packages. Green leafy local underutilized vegetables viz. Marsang (Acmella oleracea), Okobereng (Solanum sp), Oyik (Pouzolzia hirta), Oji (Elatostema sessile) and Olap (Sida acuta) were subjected to pre-packaging in low density polyethylene bags and the packages were stored at ambient condition (27-29 °C temperature and 50-70 % relative humidity). The results indicated that pre-packaged leaves were superior over unpacked leaves throughout the period of storage in controlling the physiological loss in weight (PLW), yellowing and sensory quality. It was found that the sensory quality of Okobereng and Oji was found to be acceptable even up to 5-6 days with a PLW of 9.3 % and 7.31 % as against 1 day without pre-packaging with a PLW of 21.05 % and 28.26 %, respectively, when stored at ambient temperature. Thus, it can be concluded that leafy vegetables packed in low density polyethylene was superior over those stored in open storage condition throughout the storage period in controlling the PLW, yellowing and sensory quality.

KEYWORDS Leafy vegetables, underutilized, polyethylene, PLW, pre-packaging

INTRODUCTION
In the tribal society of Arunachal Pradesh, use of plants with medicinal values, as vegetables, in daily diet, is well known since early days. Different plant species are used in treatment of various diseases using the roots, stems leaves, bark, etc. of plants. The Adi people have tradition of eating raw and cooked leaves, young inflorescences, tender stalks and other plant parts collected from the wild or forest, as vegetable, since time immemorial. They believed that it has direct medicinal benefits by this mode of eating. Daily intake of herbal medicine in the form of vegetables might be one of the important reasons for life longevity and less occurrence of the developed world killer ailments like cancer, diabetes, heart diseases. Diversified diets, based on a range of crop species, are essential for nutritional security. Indigenous vegetables are an excellent source of vitamins and micronutrients. Increasing vegetable consumption can help alleviate malnutrition from imbalanced diets wherever it occurs, in developing countries as well as in developed countries. The intake of traditionally consumed wild edible underutilized fruits, nuts, and vegetables is nowadays receiving renewed attention, due to the recognition of their potential benefits for human health (Sanchez Mata et al. 2012, Nandal and Bhardwaj 2014, Singh et al. 2014).

However, inspite of many health benefits, these vegetables maintain their freshness for a day or two in ambient condition due to their high metabolic activities after harvest. The shelf life of these commodities can be increased only if rates of these metabolic activities are reduced. Previous reports indicated the efficacy of consumer size polyethylene bags to increase shelf life of leafy greens (Waskar et al. 1988, Ambrose et al. 2015). Packaging increases the shelf life by creating a modified atmosphere in the
Effect of debittering techniques on the chemical characteristics of stored kinnow juice

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Received: April 4, 2017, Revised: October 5, 2017, Accepted: October 22, 2017

ABSTRACT Development of bitterness is the single most important hindrance in processing of kinnow mandarin juice. Five different debittering methods viz, lye, florosil, naringinase, lye and florosil, florosil and naringinase were used for the debittering of kinnow juice. Among the different debittering techniques, higher values of TSS (12.52 °B) and ascorbic acid (14.52 mg/100g) were observed in ‘florosil and naringinase’ and ‘naringinase’ treated kinnow juice, respectively. The TSS, acidity and ascorbic acid contents decreased whereas, reducing sugars and total sugars contents increased with the storage. Among different debittering techniques, ‘lye’ and ‘naringinase’ treatments proved beneficial for removal of bitterness of kinnow juice. Debittered kinnow juice was organoleptically evaluated in which ‘control’ juice was rated moderately bitter whereas ‘lye’ treated was rated between ‘neither bitter nor sweet’ and ‘not bitter’. It was concluded that naringinase enzyme was best among all treatments given for removal of bitterness and also had not much effect on characteristics of stored juice.

KEYWORDS Debittering, bitterness, kinnow juice, lye, florosil, naringinase

INTRODUCTION Sensory quality attributes such as taste, colour and flavour determines food selection. As the consumer rejects bitter or astringent taste of orange juice obtained from immature fruits therefore bitterness should be reduced by giving appropriate treatments. India ranks 4th in production of citrus fruits, in the world (FAO 2016). Within the country, citrus fruits, occupy 3rd position after mango and banana in production (Anonymous 2015). Generally, citrus fruits like oranges are easily processed due to less number of seeds but kinnow mandarin is high seeded cultivar and causes problems in extraction of juice. The major hurdle in citrus processing, particularly in kinnow mandarin, is development of bitter taste in the juice. Without proper debittering technology the profitable citrus industry cannot flourish. Two classes of chemical compound namely, limonoids and flavonoids responsible for bitterness in variety of citrus juices. The flavonoids cause bitterness of fresh juice, whereas, limonoid bitterness develops slowly during storage of juices (Premi et al. 1996). Many attempts have been made and much research has been carried out to debitter the citrus juices involving physical separation using adsorbent resins. Different resins like polyamide, polystyrene, ion exchange and adsorbent are used for their relative efficiency for adsorbing limonin and naringin from juices. These resins remove upto 85 % limonin from grapefruit juice (Johnson and Chandler 1985, Manlan et al. 1990). The present investigation was therefore carried out to remove bittering principles for production of palatable kinnow juice.

MATERIALS AND METHODS
Juice extraction
The juice was extracted by using single screw juice extractor and filled in bottles and pasteurized (80±5 °C for 30 min) for further analysis.
Effect of foliar sprays of micronutrients on plant growth and yield of lentil under rainfed condition of Uttarakhand hills

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Received: October 13, 2017, Revised: December 26, 2017, Accepted: December 26, 2017

ABSTRACT A field experiment was conducted during 2015-16 at VCSG Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India to study the effect of micronutrients on growth and yield of lentil (Var VL 126) under rainfed conditions of Uttarakhand hills. The experiment consisted of eight treatments viz. T0-RDF (N:P:K-20:40:20 kg ha⁻¹), T1-RDF+ Zn 50 ppm, T2-RDF+ Zn 100 ppm, T3-RDF+ Fe 50 ppm, T4-RDF+ Fe 100 ppm, T5-RDF+ B 50 ppm, T6-RDF+ B 100 ppm and T7-RDF+ Zn+ Fe+ B (50 ppm each) laid out in randomized block design with three replications. The data indicated that RDF+ Fe 50 ppm recorded significantly higher plant height, plant spread and number of nodules per plant. Seed yield was recorded maximum under RDF+ Fe 50 ppm which was statistically on par with RDF+ B 50 ppm. There was 33 % increase in seed yield in RDF+ Fe 50 ppm than the RDF. B:C ratio also registered maximum in RDF+ Fe 50 ppm.

KEYWORDS Lentil, micronutrient, iron, boron, zinc

Lentil, the third most important pulse crop of north India, is mainly grown as a rainfed crop in Uttarakhand (Singh and Singh 2014). It contains high levels of protein (20-30 %), minerals (2-5 %), vitamin B9 and prebiotic carbohydrates (Thavarajah et al. 2008).

Micronutrients like zinc, iron and boron play an important role in increasing yield of pulses through their effect on photosynthesis, respiration, symbiotic nitrogen fixation and other enzymatic and biochemical reactions. Micronutrients are highly required nowadays by lentil crop because of more removal of micronutrients from long-term crop production, increased use of only high-analysis fertilizers, higher crop yields accompanying higher micronutrient requirement, less use of animal manures in crop production and induction of micronutrient deficiencies by high P concentrations from long-term applications. Therefore, present study was undertaken to evaluate the effect of micronutrients on growth and yield of lentil.

A field experiment was conducted during the rabi season of 2015-16 at College of Forestry, VCSG University of Horticulture and Forestry, Ranichauri, Uttarakhand. Soil was silty clay loam, of medium depth, with acidic pH, having 0.75 % organic carbon, 225 kg ha⁻¹ available N, 15 kg ha⁻¹ available P and 405 kg ha⁻¹ available K. The experiment was laid out in randomized complete block design (single factor RBD) with eight treatments and three replications. The data were analyzed by using statistical software STPR3. The treatments comprised of T0-RDF (N:P:K-20:40:20 kg ha⁻¹), T1-RDF+ Zn 50 ppm, T2-RDF+ Zn 100 ppm, T3-RDF+ Fe 50 ppm, T4-RDF+ Fe 100 ppm, T5-RDF+ B 50 ppm, T6-RDF+ B 100 ppm and T7-RDF+ Zn+ Fe+ B (50 ppm each). Two sprays of micronutrients were made, first at 30 days after germination (DAG) and second at 50 % flowering stage. The variety of lentil VL-126 was raised by following all recommended cultural practices. Climate of experimental site was humid and temperate, with cold winter. Total precipitation during growing season of the crop was recorded 150.3 mm, whereas mean
Path coefficient analysis of wheat varieties of southern states in India

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Received: July 6, 2017, Revised: September 19, 2017, Accepted: September 25, 2017

ABSTRACT Yield components and some morphological characters were studied in seven wheat varieties in order to find out the genetic association of different characters towards grain yield. The experiment was conducted in randomized block design (RBD) with four replications, at Adhiyamaan college of Agriculture Research, Athimugam, Tamil Nadu during 2016-17. Path analysis identified that grains spike⁻¹ had the highest positive direct influence on grain yield followed by 1000 grain weight, days to maturity and tillers m⁻². Grain weight spike⁻¹, days to heading, spike length and plant height had negative direct influence on the grain plot⁻¹. Researchers emphasize the need for component analysis in which correlation of each yield component with yield and within each other is determined. Thus the exact contribution of each component can be figured out. A path coefficient is a standardized partial regression coefficient and as such, measures the direct influence of one trait upon another and permits the separation of a correlation coefficient into components of direct and indirect effects (Dewey and Lu 1959).

The aim of the present study was to find out the interrelationship and association of yield and yield components and to measure the direct and indirect influence of these component characters on yield using path coefficient analysis. The information thus obtained will be useful to determine the most important yield components, which can be used to develop appropriate selection indices for the increased grain production in southern states in India.

Experiment was conducted at Adhiyamaan College of Agriculture and Research, Athimugam, Tamil Nadu, during 2016-17. Seven wheat varieties (MACS 6222 (check), DDK 1053, MACS 5047, DDK 1052, MACS 5049, DDK 1029 (check) and HW 1098 (check)) including three varieties as standard checks, were grown in a randomized block design with four replications. Each plot comprised 12 rows. The row length was 3 m, with row to row spacing of 22.5 cm. Basel application of urea, SSP and MOP were applied @ 120: 60: 40 kg of NPK/ha. Data were recorded on five random plants for the characters comprising, days to 50 % heading, plant height (cm), days to maturity, number of tillers meter⁻², spike length (cm), grains spike⁻¹, grain weight spike⁻¹ (g), 1000 grain weight (g) and yield plot⁻¹ (kg) and then averages were calculated except for days to heading and days to maturity, which were based on 50 % plants plot⁻¹. Analyses of variance

KEYWORDS Path analysis, morphology, spike, yield

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Correlation studies in gladiolus

SK PATRA ● CR MOHANTY
Received: April 17, 2017, Revised: October 1, 2017, Accepted: 3 October, 2017

ABSTRACT An experiment was conducted to find out the association among various characters taking 19 characters for observations among 30 genotypes of gladiolus, grown over two successive years. The pooled data was analyzed for correlation studies and the result revealed that a significant positive association was noticed both at phenotypic and genotypic level for number of florets per spike with distance between two florets, number of florets remain open at a time and bloom life whereas length of spike had significant positive association with rachis length, number of floret per spike, distance between two florets and number of florets remain open at a time.

KEYWORDS Gladiolus, correlation, positive and negative association

Gladiolus, a member of family Iridaceae and subfamily Ixoideae, is one of the most popular ornamental bulbous plants grown commercially in many parts of the world for its fascinating flowers with variety of colours, huge form of florets and good keeping quality. It stands fourth in the international cut flower trade after carnation, rose and chrysanthemum. The demand for new quality cultivar is ever increasing all over the world and this demand is seen in our country also. Every now and then, a superior cultivar replaces the existing one which is in many respects very similar to it. This is a continuous process and the demand for still better cultivars is there all the time. Besides, the cultivars lose their existence in the course of time. Thus, the situation demands to continuously breed new cultivars. It is vital to have understanding of the association between the component characters and their relative contribution to economic yield (length of spike, size of floret and number of florets per spike) to bring about a rational improvement in gladiolus in the desired direction. Correlation can show relative influence of various components on economic yield and contributing traits and indicate those characters upon which more emphasis should be given by the breeder during selection.

The present investigation was carried out during the period from November to May 2010-11 and 2011-12 in form of field experiments at the Department of Floriculture and Landscaping, College of Agriculture, OUAT, Bhubaneswar. The experiment was laid out in RBD with three replications. The row to row and plant to plant spacing were maintained at 30 cm x 20 cm, respectively. Thirty genotype of gladiolus, collected from the Directorate of Horticulture, Government of Odisha, imported from the Netherlands were used for the investigation. According to statistical methods of agricultural workers, the experimental data were recorded on five randomly selected plants in each plot and subjected to variance and covariance analysis (Panse and Sukhatme 1985). It has also been proposed that the correlation at phenotypic and genotypic levels between the pairs of characters were calculated from variance and covariance components (Al-Jibouri et al. 1958).

Estimates of genotypic and phenotypic correlation coefficients for all 19 characters related to flower yield (length of spike and number of florets/spike) provided useful information for choice of characters in selection programme. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection is based for genetic improvement for a particular character. A positive correlation between desirable characters is favourable to the plant...
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<tr>
<th>Abbreviation</th>
<th>Symbol</th>
<th>Description</th>
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<tr>
<td>Above mean sea level</td>
<td>amsl</td>
<td>Limited</td>
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<td>at the rate</td>
<td>@</td>
<td>litre or liter</td>
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<td>centimeter</td>
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<td>Messrs</td>
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<tr>
<td>degree centigrade</td>
<td>°C</td>
<td>meter, metre</td>
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<td>et caetera, et coetera or et cœtera</td>
<td>etc</td>
<td>milligram</td>
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<td>exampli gratia</td>
<td>e.g.</td>
<td>parts per million, parts per billion</td>
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<td>Figure</td>
<td>Fig</td>
<td>per cent</td>
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<td>Gram</td>
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<td>per ha or per litre or per kg</td>
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<td>Hectare</td>
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<td>hour(s)</td>
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<td>square meter, cubic meter etc</td>
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<tr>
<td>international unit</td>
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<td>it is or that is</td>
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<tr>
<td>Kilogram</td>
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<td>kilometer, kilometre</td>
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<td>weight by weight</td>
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<td>lesser than, greater than</td>
<td>&lt;, &gt;</td>
<td>tonne(s), ton</td>
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Journal of Hill Agriculture thankfully acknowledges immense contribution of the following referees who devoted their precious time for evaluation of different manuscripts and suggested improvements for the betterment of the journal.

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CORIGENDUM
The author(s) name of paper entitled “Soil potassium release as indices of potassium supplying power of coastal soils of West Bengal” published at pages 319-324 of Journal of Hill Agriculture Vol 8(3), may be read as “RANJIT PANDA and SK PATRA” instead of “RANJIT PANDA and SK PATRA”.

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- Effect of various pre-harvest treatments on storage quality of peach cv. July Elberta L SOPHIA DEVI • KS THAKUR
- Changes in quality attributes during storage of underutilized green leafy vegetables PILOO NGANGBAM • AK PHURAILATPAM • SR SINGH
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- Path coefficient analysis of wheat varieties of southern states in India P LAKSHMANAKUMAR • S GANGADHARAN • D RAJARAJAN • R SABAN • J KABARIEL • R HARISH
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