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RESEARCH ARTICLE :

Effect of resource constraints on growth and yield of cowpea (*Vignaunguiculata* L. Walp)

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SUMMARY : A field experiment was conducted during *Kharif* season of 2015 Experimental Farm of Agronomy section, College of Agriculture, Latur to study the effect of production factors or constraints and their combinations on growth and yield of cowpea var. Konkan Sadabahar. The results indicated that adoption of full package of practices (fertilizer + weeding + plant protection) was recorded highest values of growth and yield parameters *viz.* maximum plant height (26.45 cm), higher number of branches (4.80), more number of leaves (15.47), dry matter plant^{-1}(15.58 g) and maximum number of pod plant^{-1}(4.84) and pod yield plant^{-1}(5.84 g), highest seed yield (738 kg ha^{-1}) and maximum harvest index (23.85). As the constraints increased growth and yield characters get reduced. Among the various constraints (weeding + plant protection) was given lowest growth and yield attributes as compared to full package of practices *viz.*, minimum plant height (10.74 cm), lower number of branches (1.80), less number of leaves (4.74), dry matter plant^{-1}(3.47 g) and minimum number of pod plant^{-1}(3.10) and pod yield plant^{-1}(2.78 g)lowest seed yield (136 kg ha^{-1}) and lowest harvest index (19.89) and found to be as a major resource constraints in cowpea production.

KEY WORDS :
Cowpea, Resource constraints

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BACKGROUND AND OBJECTIVES

Cowpea (*Vignaunguiculata* L. walp) is a native to Central Africa and belongs to the family Fabaceae. It is eaten in the form of grain, green pods and leaves. Cowpea is known as 'vegetable meat' due to high amount of protein in the grain with better biological value on dry weight basis. The grain contents 26.61 per cent protein, 3.99 per cent lipid, 56.24 per cent carbohydrates, 8.60 per cent moisture, 3.84 per cent ash, 1.38 per cent crude fibre, 1.51 per cent gross energy and 54.85 per cent nitrogen free extract. Cowpea is one of the most important food legume crops in the semiarid tropics covering Asia, Africa, Southern Europe and central and South America. A drought tolerant and warm weather crop, cowpeas are well adopted to the drier region of the tropics, where other food legumes do not perform well. It also has the useful ability to fix atmospheric nitrogen through its root nodules. It grows well in poor soils with more than 85 per cent sand and with less than 0.2 per cent organic matter and low level of phosphorus. According to the United State Department of Agriculture (USDA) food database, the leaves of the cowpea plant have the highest per cent age of calories from protein among vegetarian foods.

RESOURCES AND METHODS

A field experiment was conducted during *Kharif* season of 2015Experimental Farm of Agronomy section, College of Agriculture, Latur The soil of the experimental site was medium, black in colour with good drainage and alkaline in reaction having pH of 7.8. Soil was low in available nitrogen (215.86 kg ha^{-1}), medium in available phosphorus (20.42 kg ha^{-1}), very high in available potassium (485.89 kg ha^{-1}).

The experiment was laid out in Randomized Block Design. The seven treatments were replicated thrice. The treatments were T_1: Full package of practices, T_2: T_1 - Fertilizer, T_3: T_1- Weeding, T_4: T_1 - Plant Protection, T_5: T_1 - (Fertilizer + Weeding), T_6: T_1 - (Fertilizer + Plant protection), T_7: T_1 - (Weeding + Plant Protection). The seeds of variety Konkan Sadabaharwere sown at the depth of 5 cm. Sowing was done by dibbling by using seed rate 15 kg ha^{-1}. The gross and net plot size was 5.4 x 4.2 m and 4.8 x 3.6 m, respectively. The total rainfall received during growth period of cowpea was 297.5 mm with 22 rainy days. The recommended dose of fertilizer was 25:50:00 kg NPK ha^{-1} applied as per treatments through Urea and single super phosphate. The drenching of Chloropyriphos @ 2 ml $lit^{-1}$to control the root rot, spraying of Dimethoate (Roager) 1 ml lit^{-1} + Carbendazim (Bavistin) 1 g lit^{-1}, Qunolphos 1.5 ml lit^{-1} + Acephate2 g lit^{-1} and Emamectin benzoate 5 % SG (Proclaim) @ 0.2 g lit^{-1} of water for the control of semilooper , sucking pests (Aphids) and pod borer, respectively as per the treatments was done. Weed control was done by hand weeding. Statistical analysis of the data was carried out using standard analysis of variance.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads :

Growth and development :

Data presented in Table 1 showed effect of different treatments on height of cowpea was found to be significant. The application of full package of practices (T_1) recorded maximum plant height over rest of the constraints. While missing of weeding and plant protection treatment (T_7) recorded minimum plant height followed by T_6 and T_5 where fertilizer along with plant protection and weeding were missing, respectively.

The role of phosphorus in cell division could be responsible for the increase in plant height. This finding is in conformity with that of Namakka *et al.* (2016), Ayodele and Oso (2014).Highest plant height was probably resulted from effective weed control causing maximum nutrient utilization by the crop plants and hence, maximum plant height was recorded with full package of practices (T_1). Getachew Mekonnen *et al.* (2015),Incidence of root rot at early growth stages of crop is also responsible for reduction in height because due to incidence of root rot physiological and metabolic activity of the plant get reduced. Similar results were reported by Sitansu Pan *et al.* (2011) in cowpea and Raid Sedki Raid EI- Mohamedy (2008) in pea plant.

The highest number of branches per plant was produced due to application of full package of practices (T_1) and no weeding and plant protection (T_7) produced less number of branches followed by (T_6) which was due to incidence of root rot reduced metabolic activity (Sitansu Pan *et al.* (2011). The number of branches per plant was influenced by the presence of weeds. This confirms the adverse effects of the weeds on crop. This result was in conformity with the results of Hanumanthappa *et al.* (2012). The positive effect of phosphorus on number of branches per plant could be due to the significant role of the element on cell division and cell elongation which resulted to the production of more lateral buds that developed into branches. Similar results were stated by Namakka *et al.* (2016), Ayodele and Oso (2014), Magani and Kuchida (2009).

The maximum numbers of leaves was recorded with application of full package of practices (T_1) and which was significantly lowest when weeding and plant protection practice in combination was not applied (T_7) which was followed by the treatment (T_6). This could be attributed to the competition of the crops with the weeds for moisture and nutrients such that the plant could not produce more number of leaves so as to conserve available moisture for critical growth stages. The same factor could be responsible for the reduced leaf area recorded when weeding was not done. These results were in the line of Madukwe *et al.* (2012). Phosphorus is mobile in plants and highly concentrated in places of cell division and development, hence, its positive role on enhancing numbers of leaves and leaf area per plant. Similar results were identified by Ayodele and Oso (2014), Magani and Kuchida (2009). Another reason for decrease in number of leaves and leaf area at 45 and 60 DAS was attack of semilooper pest which feed on green leaves and caused considerable damage to crop at growing periods.

The application of full package of practices (T_1) was produced higher dry matter. This was due to availability of phosphorus increased the fresh and dry yield of cowpea plants particularly. This means dry matter was increased with the application phosphorus. Also availability of N to crop enhances growth and increase in dry matter accumulation. Suppression of weeds resulted in good crop stand utilizing maximum crop plant nutrients and hence, comparatively resulted in higher dry matter production on plant. Dry matter accumulation in plants was drastically reduced when weeding and plant protection was not given (T_7). This was due to weeds competing with crop plants for light, water, space and nutrients and utilizes available resources more efficiently than crop resulted in reduction of dry matter production of plant. Incidence of pests and disease also reduce physiological and metabolic activities of plant cause reduction of dry matter accumulation. These results obtained were agreed with the reason obtained by Mekonnen *et al.* (2015) and Nkaa *et al.* (2014). Generally overall decrease in dry matter production was observed due to the adverse effect of moisture deficit to its effect on the rate of photosynthesis, shoot water potential and carbon movement. This result was in the line of Hussein

Table 1 : Effect of resource constraints on growth of cowpea

Treatments	Plant height (cm)	No. of branches plant^{-1}	No of functional leaves plant^{-1}	Dry matter plant^{-1}	No of pods plant^{-1}
T_1: Full package of practices	26.45	4.80	15.47	15.58	4.84
T_2: T_1-Fertilizer	22.30	3.70	12.77	12.60	4.01
T_3: T_1-Weeding	20..32	3.50	11.00	10.19	3.83
T_4: T_1-Plant protection	18.82	3.18	8.65	8.40	3.64
T_5: T_1-(Fertilizer + Weeding)	16.42	2.94	7.63	6.93	3.48
T_6:T_1-(Fertilizer + Plant protection)	13.36	2.55	5.72	4.90	3.33
T_7: T_1-(Weeding + Plant protection)	10.74	1.80	4.74	3.47	3.10
S.E. ±	1.11	0.18	0.57	0.52	0.18
C.D.(P=0.05)	3.42	0.55	1.74	1.61	0.55
General Mean	18.34	3.21	9.21	8.87	3.75

Table 2: Effect of resource constraints on yield of cowpea

Treatments	Pod yield plant^{-1}(g)	Seed yield (kg/ha)	Biological yield (kg/ha)	Harvest index
T_1: Full package of practices	5.84	738	3094	23.85
T_2: T_1-Fertilizer	5.07	503	2176	23.12
T_3: T_1-Weeding	4.80	463	2032	22.79
T_4: T_1-Plant protection	4.00	374	1727	21.65
T_5: T_1-(Fertilizer + Weeding)	3.50	311	1451	21.43
T_6:T_1-(Fertilizer + Plant protection)	3.28	277	1307	21.19
T_7: T_1-(Weeding + Plant protection)	2.78	136	684	19.89
S.E. ±	0.27	21	109	-
C.D. (P=0.05)	0.82	66	335	-
General Mean	4.18	400	1781	22.45

et al. (2012).

The treatment full package of practices (T_1) produced higher number of pods plant^{-1}. This might be due to the more vigorous leaves under low infestation level helped to improve the photosynthetic efficiency of the crop and resulted in production of more numbers of pods. Similar results were also noted by Mekonnen *et al.* (2015). Weeds suppression resulting healthy plant growth and ultimately resulted in more pod formation. Attack of sucking pest, root rot and presence of weeds at grand growth stages were responsible for low numbers of pod formation under weeding and plant protection measures was not applied (T_7).

Yield and yield attributes:

The yield attributes of cowpea *viz.*, pod yield plant^{1}, seed yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index were influenced significantly due to different resource constraints treatments. Though the highest values of these characters were observed with the application of full package of practices (T_1) while lowest values were observed with the treatment of T_7 where weeding and plant protection was not done.

Application of full package of practices (T_1) recorded significantly higher pod yield plant^{-1} (5.84 g).These results could be attributed because P enhanced fresh weight of pods plant^{-1} [Nkaa *et al.* (2014)]. Treatment of T_7 (no weeding and plant protection) recorded significantly lowest pod yield plant^{-1} (2.78 g),This results was observed due attack of pod borer at pod filling stage which caused considerable damage to pods caused reduction in pod yield, seed yield plant^{-1} and number of seeds plant^{-1} . In general mid-season stress at early pod filling also responsible for low pod yields (Hussein *et al.* (2012).

Application of full package of practices (T_1) recorded significantly higher seed yield (738 kg ha^{-1}), straw yield (1381 kg ha^{-1}) and biological yield (1781 kg ha^{-1}). This was due to phosphorus fertilizer application resulted to increased grain yield of cowpea. This could be attributed to the fact that phosphorus helped in producing higher nodulation count, which resulted in higher nitrogen fixation. This led to the production of more leaves, leaf area and branches for higher photosynthetic ability. Nitrogen availability depends more or less on phosphorus. Cowpea requires large quantity of P in young cells such as shoot and root tips where metabolism is high and cell division is rapid. It also aids in flower initiation, seed and fruit development. These results are in the line of Hussein *et al.* (2012) and Magani and Kuchinda *et al.* (2009). Suppression of weeds that resulted in higher numbers of leaves and leaf area which could have made way for greater reception of light encourages photosynthetic process of the plants which was required for pod filling and improve yield. Minimum seed yield was obtained with the treatment of T_7 where weeding and plant protection was not given. Weeds increased crop competition for inputs could not produce more leaves and leaf area which ultimately lead to low assimilation of photosynthetic, causing seed yield reduction in cowpea. Mekonnen *et al.* (2015), Madukwe *et al.* (2012), Hanumanthappa *et al.* (2011) were reported same results.

The maximum seed, straw and biological yield obtained due to application of full package of practices (T_1) was recorded higher value of harvest index (23.85). The treatment of where weeding and plant protection was not done (T_7) were gave lowest harvest index (19.89). This was due to lower growth and development, resulted to lower seed, straw and biological yield. Similar results were obtained by (Getachew Mekonnen*et al.* (2015), Hussein *et al.* (2012).

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