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Impact of maize+blackgram intercropping system and influence of plant geometry on growth parameters

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Abstract
A field experiment was conducted during kharif season 2015-16 at a farm of SGRR(PG) College to study the maize+ blackgram intercropping system to planting geometry. The soil of the experimental field was well drained, sandy loam and slightly alkaline in reaction. The treatment comprises of two cropping system (Maize+blackgram and maize alone), Two planting geometries (normal and paired) The result indicated that growth parameter (plant height, plant spread and dry matter accumulation per plant) in maize were significantly superior in Maize+Blackgram intercropping system then the sole crop.

Keywords: Maize, blackgram and intercropping

Introduction
Maize (*Zea mays*) is the third most growing crop among all the cereals. It is considered as major food crop as well as its other uses like energy etc. It is suited to various climatic zones of India and also has high yield potential. 60% area contributed by Karnataka, Andhra Pradesh, Maharashtra, UP, Tamil Nadu, Rajasthan together.

Intercropping is cultivating two or more crops on the same piece of land at the same time together to increase productivity per unit of land. In this system, all resources of environment is utilised to maximise crop production per unit area per unit time. Intercropping has many ecological, biological and socio economical advantages over monocropping.

Intercropping of cereal with legume is commonly practiced in Asia, South America and Africa. Intercropping of legumes is responsible for efficient utilization of resources. Maize + legume intercropping is more productive and profitable as compare to sole crop. Hybrids increases the scope to utilize vacant space of maize by intercropping with legume crops and also by adjusting the crop geometry for higher productivity.

Efficiency of production in cereal legume intercropping could be improved by minimizing inter-specific competition between the component crops for growth limiting factors (Willey 1979) [4]. Physical and economical intercropping depends on proper planting pattern. Cereal - legume intercropping offer scope for efficient and sustainable agriculture (IAEA 1990) [3].

Intercropping is vogue in irrigated areas of north India, but under dehradun condition less work has been done. Thus, present study was planned to evaluate agronomic implication and economic feasibility of maize + blackgram intercropping system under plant geometry in dehradun, uttrakhand was done during kharif season 2015 with the objective:

To find out most appropriate planting geometry for maize+blackgram intercropping system.

Material method
The field experiment was conducted at the experimental located at a altitude of 30*21'N and longitude of 77*52'E with elevation of 516.5m above mean sea level.

Climate and weather: The mean weekly maximum temperature was 39.2*C recorded in the last week of june it is decline and reaches to minimum at the time of harvest. Lowest temperature during third week of October was 18*C. Relative humidity varies from 80 to 59.9 and 73.7 to 23%. Total rainfall received during crop period was 651.6mm.

Soil texture was sandy loam. Sand % was 45.2%, Silt-28.5% and Clay-26.3%, bulk density-1.42Mg/m3. Maize (sole) and Maize+ Blackgram cropping system was taken. Planting geometry: Normal (50cm), Paired (25/60cm). Seed were placed 7-8cm deep with furrow opener at plant to plant distance 20and 10cm with seed rate 20and 15kg/ha for maize and blackgram. Excess plant were thinned out 21 DAS to ensure intra row spacing of 20cm for maize and 10cm for blackgram in all plots.

Observations for maize

Population: Plant population counted for net plot area after 21 days of sowing and at the time of harvesting was considered for recording the mortality %

Mortality % = x 100

Growth and development

Observation on growth parameters was recorded at 25,50,75 DAS and at harvesting stage of crop.

Plant height

plant height from 5 randomly selected tagged plants was measured from ground surface to the tip of top most leaf at 25 days after sowing and at maturity and finally average plant height was recorded.

Plant spread

It was measured by placing the scale on canopy laterally on 5 tagged plants and the average value was computed.

Dry matter accumulation

Five plants from each plots randomly selected and harvested. Plant were chopped and kept in oven at 70_+1C (Jackson 1973) [2] till constant weight was achieved. Total dry weight taken and then worked out the average as g/plant.

Observations for blackgram

Population: Plant population counted for net plot area after 21 days of sowing and at the time of harvesting was considered for recording the mortality %

Mortality % = x 100

Growth and development

Observation on growth parameters was recorded at 25,50,75 DAS and at harvesting stage of crop.

Plant height

Plant height from 5 tagged plants was measured from surface to the base of fully developed leaf and then average plant height was recorded in cm.

Plant spread

It was measured by placing the scale on canopy laterally on each of the randomly selected 5 tagged plants and the average value was recorded in cm.

Dry matter accumulation

It was recorded by 5 sampled plant from second row of each plot leaving 0.5m row length on both side of row. Afterthat sample from different plants were sundried and then put in oven at 70'C_+1'C for 45 hours and dry weight of individual plant by dividing total dry weight by 5.

Statistical analysis

The treatment differences were tested by using "F" TEST and critical differences were calculated.

Result and discussion

Table 1: Initial Final plant population and mortality of maize

Treatment	Plant population		Mortality (%)
	Initial	At maturity	
Planting geometries			
Normal (50cm)	40.5	37.7	5.7
Paired (25/60cm)	40.7	37.7	5.6
S.Em. +_	0.3	0.3	0.2
C.D. (P=0.05)	0.8	NS	NS

Table 2: Initial Final plant population and mortality of Blackgram.

Treatment	Plant population		Mortality (%)
	Initial	At maturity	
Planting geometries			
Normal (50cm)	160.9	155.3	2.4
Paired (25/60cm)	160.7	154.1	3.0
S.Em. +_	0.7	0.9	0.4
C.D. (P=0.05)	NS	NS	NS

Table 3: Plant height (cm) of maize

Treatment	Plant height (cm) Days after sowing			
	25	45	70	At maturity
Planting geometries				
Normal (50cm)	47.9	152.4	170.7	174.9
Paired (25/60cm)	53.4	127.8	156.3	159.5
S.Em. +_	0.2	0.7	1.3	0.5
C.D. (P=0.05)	0.7	2.1	3.8	1.6

Table 4: Plant height (cm) of blackgram

Treatment	Plant height (cm) Days after sowing		
	30	55	At maturity
Planting geometries			
Normal (50cm)	28.4	44.0	52.9
Paired (25/60cm)	26.0	41.2	46.3
S.Em. +_	0.2	0.5	0.5
C.D. (P=0.05)	0.7	1.7	1.6

Table 5: Plant spread (cm) of maize

Treatment	Plant height (cm) Days after sowing			
	25	45	70	At maturity
Planting geometries				
Normal (50cm)	40.6	81.3	56.9	56.2
Paired (25/60cm)	42.8	74.1	54.2	43.4
S.Em. +_	0.4	0.5	0.2	0.6
C.D. (P=0.05)	1.1	1.4	0.5	1.6

Table 6: Plant spread (cm) of blackgram

Treatment	Plant height (cm) Days after sowing		
	30	55	At maturity
Planting geometries			
Normal (50cm)	18.1	23.6	40.5
Paired (25/60cm)	17.0	20.5	37.8
S.Em. +_	0.4	0.4	0.3
C.D. (P=0.05)	1.2	1.3	1.1

Table 7: Dry matter accumulation (g/plant) of maize

Treatment	Dry matter accumulation(g/plant) Days after sowing			
	25	45	70	At maturity
Planting geometries				
Normal (50cm)	10.7	18.1	34.6	35.5
Paired (25/60cm)	11.0	18.7	34.1	34.9
S.Em. +_	0.2	0.2	0.3	0.4
C.D. (P=0.05)	NS	0.6	NS	NS

Table 8: Dry matter accumulation (g/plant) of blackgram

Treatment	Plant height (cm) Days after sowing		
	30	55	At maturity
Planting geometries			
Normal (50cm)	2.3	8.3	8.5
Paired (25/60cm)	2.3	6.2	7.2
S.Em. +_	0.1	0.2	0.2
C.D. (P=0.05)	NS	0.6	0.6

Population Studies

Maize

In normal planting initial plant population, maturity plant population and mortality % was higher when compared to paired plant geometry. Plant population increases if apply 100% NPK with Zn and PSB. This also showed low mortality compared to 100% NPK.

Blackgram

Due to fertility levels plant population varied but mortality % not show any significant variation. Under normal planting slightly higher blackgram population compare to paired planting. Application of Zn and PSB over 100% NPK gave significantly high plant population. Similar findings reported by Watiki *et al*. (1993) [8]

Plant height

Maize

At all the stages plant height was higher in intercropping than in sole cropping. Between planting geometry normal planting had taller plants as compare to paired planting at all the stages of growth. Control and recommended NPK alone not result in higher plant height as compare to combine use of NPK+ PSB+Zn at all the stages of plant growth. Similar findings reported by Malai and Muthusankovenarayanan (1999) [10].

Blackgram

Normal planting significantly had taller plants of blackgram compared to paired planting at various growth stages. Application of NPK+ PSB+Zn at all the stages of plant growth result in higher plant height compare to 100% NPK and control.

Plant Spread

Maize At all the stages plant spread was higher in intercropping than in sole cropping. Between planting geometry normal planting had more plants spread as compare to paired planting at all the stages of growth. Control and recommended 100% NPK alone not result in more plant spread as compare to combine use of NPK+ PSB+Zn at all the stages of plant growth.

Blackgram

Normal planting significantly had more plants spread of blackgram compared to paired planting at various growth stages. Application of 100% NPK+ PSB+Zn at all the stages of plant growth result in more plant spread compare to 100% NPK and control.

Dry matter accumulation

Maize

Dry matter accumulation was higher in 50-75 DAS. It was higher in intercropping than in sole cropping. Paired planting had higher dry matter accumulation as compared to normal planting system. Combined use of 100% NPK+ PSB+Zn at all the stages of plant growth result in highest dry matter accumulation compare to 100% NPK alone and control. Dry matter per plant varied between 31.4 to 40.7g.

Blackgram

Normal planting significantly had higher dry matter accumulation of blackgram compared to paired planting at various growth stages except 25DAS. Application of 100% NPK+ PSB+Zn at all the stages of plant growth result in higher dry matter accumulation per plant as compare to 100% NPK and control. At harvest, 100% NPK+ PSB+Zn resulted into higher dry matter accumulation (11.0g/plant), while minimum (4.7g/plant) noticed in control treatment.

Effect of weather on maize

In this study growth parameters improved and this was due to good vegetative growth at the cost of good development of sink. Better distribution of rainfall and optimum temperature led to good development of photosynthetic organs and finally which were responsible for good yield.

Effect of weather on Blackgram

Distribution of rainfall meet the requirement of crop and also provide favourable condition for vegetative growth of crop and this led to good development of source and sink, optimum temperature also responsible for growth and development of crop.

Effect of cropping system in maize

Growth parameters like plant height, plant spread and dry matter accumulation maximise under intercropping as compare to sole crop. This was due to the fact that intercrop with legume fix atmospheric nitrogen which was utilise by maize crop coupled with better resource utilization by border crop rows. Similar findings were reported by Natarajan (1992) [5] and Sadashiv (2004) [6]

Francis (1989) [1] indicated that biological efficiency of intercropping was improved due to exploration of large soil mass compared to monocropping.

Effect of plant geometry in maize

Growth parameters like plant height, plant spread and dry matter accumulation in maize increased in paired row planting as compared to normal planting(50cm). Increased value of growth parameter were due to the fact that intercrop with legume fix atmospheric nitrogen which was utilise by maize crop coupled with better resource utilization by border crop rows. Similar effect of resource utilization and legume effect reported by Willey (1985) [9] and Seran and Brintha (2009) [7].

Effect of plant geometry in Blackgram

Growth parameters like plant height, plant spread and dry matter accumulation per plant at maturity stage in black gram was superior in normal planting as compare to paired row planting and this is due to good utilization of resources and

more penetration to light when compared to paired planting of maize. Similar effect reported by Panwar *et al*. (1986) [12] and Pandita *et al*. (2000) [11].

Maize

Generally growth parameters of the associated crops in intercropping with cereals were adversely affected (Rao and Willey, 1983). Some workers reported positive effect on associated crops (John and Seshadri, 1943 and Panwar *et al*., 1986) [12].

Prusty *et al*. (1987) reported high dry matter accumulation (250g/plant) in maize when intercropped with soyabean. Davis and Gracia (1987) reported bean cultivars differ in dry matter distribution in branches and main stem when intercropped with maize.

Tripathi *et al*. (2008) reported effect of rabi season crops intercropped with maize at Kanpur and observe that plant height, functional leaves and dry matter accumulation /plant were more when maize was intercropped with potato followed by pea while when intercropping of toria and wheat with maize cause the maximum decrease in total dry matter production.

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