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Root Development and Nodulation in Cowpea as Affected by Application of Organic and Different Types of Inorganic/Plastic Mulches

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A B S T R A C T

The present study investigated the effects of organic and plastic mulching on root development and nodulation related biometric properties of cowpea determined at different stages of crop growth (60 DAS and at harvest after 90 DAS). At 60 DAS and 90 DAS (at harvest stage), majority of the root development parameters such as root length, number of secondary roots/lateral roots, root weight with nodules, root weight without nodules were recorded highest in plants grown under organic mulch treatments with different level of drip irrigation. Similar trend was also observed in regard to root nodulation development in various mulch treatments. Highest number of nodules per main root of plant i.e., 12.67 and 17.00 after 60 DAS and 90 DAS (at harvest stage) was observed in NM-80% and OM-60% treatments respectively, At 60 DAS and 90 DAS (at harvest stage), highest number of root nodules per secondary/lateral root (184.67 and 195.50) and total root nodules per plant (195.00 and 211.00) was recorded in organic mulch treatment plants. Fresh weight of total nodule per plant after 60 DAS and 90 DAS was recorded highest in NM-100% (2.72 gm) and OM-100 % (5.77gm). In conclusion, overall development of plant roots and root nodulation was positively affected by organic mulches while black mulch has negatively influence on these plant parameters.

Introduction

Cowpea (*Vigna unguiculata* L. Walp.), one of the important pulse crop grown globally, plays a vital role in the livelihood of many people dwelling in developing world (FAO, 2002; El Naim and Jabereldar, 2010). In India, it is cultivated in most of the country's regions and utilized for in the form of grain and leafy vegetables, pulses, green manure and green fodder. Beside this, the dried grain of cowpea is also used in several different food preparations. Cowpea seeds are rich in protein and carbohydrate content with high nutritive value and palatability (Whitebread and Lawrence, 2006). Protein content of cowpea leaves range from 27 to 43% and protein concentration of the dry grain range from 21 to 33% (Abudulai *et al.*, 2016). Cowpea is also an important component of the conventional cropping systems because of its ability to fix atmospheric nitrogen and improvement in the soil fertility. It is well suited to dry and arid conditions because of its adaptive capacity to various stressful environments, where several crop plants are

unable to grow normally (Bisikwa *et al.*, 2014; Ddamulira *et al.*, 2015). Additionally, numerous cowpea cultivars with short growing period (60 to 90 days) are suitable for such dry and drought areas. These crops are highly suitable for the efficient utilization of left over soil moisture post-harvest stage of cereal crops such as wheat or paddy.

Worldwide, use of organic and inorganic mulches in agriculture and horticulture production system has been increased recently. Various organic mulches (cereal straw, leaf debris, strawdust etc.,) and inorganic mulches (Black, silver and clear plastic etc.,) are commonly applied to the soil surface to conserve soil moisture, moderate soil temperatures, suppress weeds growth, and plant diseases propagules (Robinson, 1988; Hoitink and Boehm,1999).

In addition, the potential of mulches in improving soil structure, soil organic matter, soil nutrient uptake and increase in crop yield has also been recognized (Bhatt *et al.*, 2011; Hatami *et al.*, 2012).

Hence, conservation of soil moisture and ensuring its availability to crops growth are of critical significance under prevailing dry and arid conditions Punjab and other similar regions of India.

Although use of mulches offers several potential benefits, however, there is lack of sufficient research work relating to effects of application of organic and inorganic mulches on extent of root nodulation and root development in cowpea.

Keeping this lacuna in mind, the present study was aimed to investigate the effect of application of organic and inorganic/plastic mulches on root nodulation and root development in cowpea grown under different regime of drip irrigation.

Materials and Methods

Experimental site description

The experiment was conducted at the experimental research site of ICAR-Central Institute of Post-Harvest. Engineering and Technology, Abohar, Punjab (India). Abohar is located in plains of North-West India at 390 meters above mean sea level with a latitude of 30.167° North and longitude of 74.18° East. This location comes under hot and arid regions of Punjab with average annual rainfall of 328 mm (200-500 mm), minimum and maximum temperature ranging between 0 to 50^0 C and average insolation of 5.07 kWh/m^2/day. The soil of the field is sandy loam with ground water table of up to 2 m and low in available nitrogen, medium in available phosphorous and rich in available potassium.

Details of the experimental design and set up

Experimental design

Multilevel factorial design was used in experiment. Statistical software MINITAB 17 was used to design the experiment. Experiment involved 2 factors, namely type of mulch and irrigation level. Each factor had four levels. Type of mulch included black mulch, silver mulch, organic mulch and no mulch whereas irrigation level was maintained at 40 % of ET, 60 % of ET, 80 % of ET and 100 % of ET with the help of soil tensiometer. Paddy straw was used as organic mulch and applied at the rate of 0.4 kg straw/m^2 of bed (Size-16M length × 0.5M width). Both black and silver plastic mulches were UV stabilized LDPE sheets of 25 micron thickness. Application of mulches was done at the time of sowing. Cowpea crop was used in the study. It is sown with plant to plant distance of 40 cm under four types of mulches

and four different levels of drip irrigation. Details of various treatment used in the experiment are given in Table 1.

Data collection and analysis

Randomly three plants per plot were selected and uprooted with intact roots for the collection of data related to root length, number of secondary roots/lateral roots, root weight with nodules, root weight without nodules, number of root nodules per main root of plant, number of root nodules per secondary/lateral roots of plant, total number of root nodules per plant and fresh weight of total root nodule. Plant roots with intact primary and all secondary roots were cut from 0.5 to 1 cm above the site of emergence of lateral roots.

Plant roots with nodule were washed with running tap water and air dried under laboratory conditions. After air drying of roots, total weight of root nodule was measured by detaching individual nodules from main and secondary/lateral roots.

Also, data for all the above parameters were collected at 60 days after sowing and at harvest (90 DAS) and recorded and analyzed statistically in triplicate value. Before experiment, soil samples collected from experimental site were thoroughly mixed and were analyzed for selected soil physico-chemical properties.

Results and Discussion

The experimental findings based on the observation recorded during the course of research at various crop growth stages has been critically examined and statistically analysed. Records of various field and laboratory observations are presented with the help of tables and diagrams, wherever necessary.

Effects of application of organic and plastic mulching on root development biometric properties of cowpea root after different interval of crop growth stage

Application of various mulching and drip irrigation level and its effect various root development biometric parameters of cowpea such as root length, number of secondary roots/lateral roots, root weight with nodules, root weight without nodules was determined after 60 and 90 days after sowing (DAS).

Plant root length (cm)

The data on root length of cowpea was recorded at 60 and at harvest (90DAS) are given in the Table 2. After 60 days of cowpea sowing, plants with highest root length (33.50 cm) was observed in treatment organic mulch with irrigation applied at 100% of evapotranspiration (OM-100%) while lowest root length of 19.75 cm was observed in treatment involving black mulch with irrigation at 100 % of ET(BM-100%).

At harvest stage(90 DAS), among various treatments of organic and plastic mulches, organic mulch with irrigation applied at 80% of ET (OM-80%) treatment recorded the highest plant root length (49.00 cm) which was significantly different than treatments no mulch with irrigation applied at 100% of ET (NM-100%) showing lowest plant height i.e., 16.50. Data obtained on cowpea root length in all other remaining treatments showed values in between this highest and lowest value recorded after 60DAS and 90DAS (Figure 1).

Number of lateral roots plant

The average number of secondary or lateral roots per plant of cowpea was recorded at 60 DAS, and at harvest stage (90DAS). At all different interval of crop growth stages, the number of secondary or lateral roots per plant

differs significantly due to various treatments of organic and inorganic mulches and irrigation levels (Table 2).

At 30 DAS, among various mulch treatments, no mulch with irrigation applied at 80% of ET (NM-80%) recorded the number of secondary or lateral roots (54.50) which was significantly different from other treatments while lowest number of lateral roots (18.00) was recorded in black mulch with irrigation applied at 80% of ET (BM-80%).

The similar trend was recorded in observation measured at the time of harvest (90DAS) where highest number of lateral roots (59.00) obtained in black mulch with irrigation applied at 80% of ET (BM-80%) was significantly different than the lowest value of lateral roots (21.00) obtained in black mulch with irrigation applied at 80% of ET (BM-80%).

Total fresh root weight with nodules

At 30 days of cowpea crop growth stage, maximum fresh root weight with nodules (30.25 gm) was recorded in treatment involving organic mulch with irrigation applied at 100% of ET (OM-100%). It was significantly different from other treatments and the minimum observation (5.11gm) recorded treatment i.e., black mulch with irrigation applied at 80% of ET (BM-80%) The slightly similar trend was observed in observation recorded at the time of harvest (90DAS). At harvest stage, organic mulch with irrigation applied at 100% of ET (OM-100%) treatment recorded the maximum fresh root weight with nodules (45.63gm) which was significantly different from other treatment. No mulch treatment with irrigation applied at 100% of ET (NM-100%) recorded the minimum weight (10.21 gm) of fresh root with nodules at crop harvest stage (Table 2).

Table.1 Details of various treatments used in the experiment

Types of mulch used	Treatment detail	Treatment code
Organic Mulch	Organic mulch + Irrigation - 40% of Evapotranspiration	OM-40%
	Organic mulch + Irrigation - 60% of Evapotranspiration	OM-60%
	Organic mulch + Irrigation- 80% of Evapotranspiration	OM-80%
	Organic mulch + Irrigation -100% of Evapotranspiration	OM-100%
Black Mulch	Black mulch + Irrigation - 40% of Evapotranspiration	BM-40%
	Black mulch + Irrigation - 60% of Evapotranspiration	BM-60%
	Black mulch + Irrigation - 80% of Evapotranspiration	BM-80%
	Black mulch + Irrigation-100% of Evapotranspiration	BM-100%
Silver Mulch	Silver mulch + Irrigation-40% of Evapotranspiration	SM-40%
	Silver mulch + Irrigation-60% of Evapotranspiration	SM-60%
	Silver mulch + Irrigation-80% of Evapotranspiration	SM-80%
	Silver mulch + Irrigation-100% of Evapotranspiration	SM-100%
No mulch	No mulch + Irrigation-40% of Evapotranspiration	NM-40%
	No mulch + Irrigation-60% of Evapotranspiration	NM-60%
	No mulch + Irrigation-80% of Evapotranspiration	NM-80%
	No mulch + Irrigation-100% of Evapotranspiration	NM-100%

Table.2 Effect of application of organic and plastic mulching on architecture and associated parameters cowpea root after different interval of crop growth stage (Data are given as mean ± SE)

Treatment	60 days after sowing(DAS)				90 days after sowing (DAS)			
	Root length plant^{-1} (cm)	Number of lateral roots plant^{-1}	Root weight with nodules plant^{-1} (gm)	Root weight without nodules plant^{-1} (gm)	Root length plant^{-1} (cm)	Number of lateral roots plant^{-1}	Root weight with nodules plant^{-1} (gm)	Root weight without nodules plant^{-1} (gm)
OM-40%	28.50±0.87	36.00±6.35	13.13±1.89	11.73±1.92	25.75±6.25	37.50±4.91	21.55±0.85	16.16±0.53
OM-60%	23.75±1.88	42.50±1.44	14.58±0.01	12.45±0.59	45.00±2.00	46.00±1.15	24.35±1.10	17.43±1.38
OM-80%	27.25±1.59	21.50±1.44	9.17±0.19	6.96±0.30	49.00±12.00	25.00±1.15	28.60±2.81	19.26±2.35
OM-100%	33.50±4.91	47.00±3.46	30.25±1.07	28.45±0.76	33.25±2.75	52.50±2.60	45.63±3.54	38.22±3.05
BM-40%	24.75±3.61	38.50±7.79	13.64±1.67	12.67±1.45	28.00±1.00	41.00±5.77	34.91±4.33	30.76±3.83
BM-60%	27.00±1.15	51.50±2.02	14.63±2.03	13.61±1.88	31.00±2.00	54.00±2.89	24.58±7.13	20.89±6.63
BM-80%	23.50±3.18	18.00±1.15	5.11±1.64	5.05±1.61	31.50±5.50	21.00±1.15	21.78±5.12	19.77±6.15
BM-100%	19.75±1.30	50.00±2.89	12.07±0.89	11.46±0.89	20.50±0.50	50.00±1.73	18.63±0.29	15.59±0.16
SM-40%	20.00±0.00	49.50±0.87	11.88±0.90	9.95±1.59	20.00±1.00	54.00±0.58	17.90±1.37	14.09±0.79
SM-60%	21.25±0.43	40.00±0.58	9.96±0.68	7.36±1.41	26.00±3.00	40.00±1.15	18.77±5.40	14.62±4.78
SM-80%	23.75±0.14	41.50±0.87	11.57±1.64	10.78±1.41	37.00±4.00	45.50±0.87	45.41±3.29	37.71±2.08
SM-100%	24.50±0.00	27.50±5.48	12.67±1.56	9.09±1.20	26.00±2.00	29.00±2.31	32.41±1.55	25.61±0.07
NM-40%	25.50±2.31	33.00±2.89	10.43±0.09	8.12±0.54	27.50±5.50	39.50±3.18	12.79±0.44	11.38±0.57
NM-60%	24.50±0.87	35.50±2.02	11.68±1.30	9.79±1.05	25.50±1.00	39.50±2.60	24.23±6.79	17.36±4.44
NM-80%	26.45±0.89	54.50±0.29	24.39±5.03	21.78±4.88	19.80±0.00	59.00±1.15	22.12±4.06	14.08±1.91
NM-100%	23.70±0.17	45.50±2.60	13.69±2.06	10.72±1.30	16.50±2.00	50.00±2.31	10.21±1.02	8.12±0.89

Table.3 Effect of application of organic and plastic mulching on root nodulation development in cowpea at different stages of crop growth (Data are given as mean ± SE)

Treatment	60 days after sowing(DAS)				90 days after sowing (DAS)			
	Total nodules main root^{-1} plant^{-1}	Total nodules lateral roots^{-1} plant^{-1}	Total root nodules plant^{-1}	Fresh wt of total nodule plant^{-1}(gm)	Total nodules main root^{-1} plant^{-1}	Total nodules lateral roots^{-1} plant^{-1}	Total root nodules plant^{-1}	Fresh wt of total nodule plant^{-1}(gm)
OM-40%	5.67±0.88	49.67±2.96	55.50±2.60	0.94±0.13	12.50±2.02	94.50±23.96	107.00±25.98	1.57±0.27
OM-60%	10.33±0.33	184.67±8.37	195.00±8.08	2.67±0.15	17.00±3.46	184.00±39.84	201.00±43.30	3.36±0.27
OM-80%	7.50±0.29	90.00±5.77	97.50±6.06	1.73±0.36	15.50±0.87	195.50±11.26	211.00±12.12	5.77±0.06
OM-100%	6.00±1.15	43.00±8.14	49.00±8.66	1.17±0.10	6.00±0.58	61.00±6.35	67.00±5.77	2.14±0.00
BM-40%	7.33±1.45	44.00±1.73	51.50±0.29	0.94±0.26	5.00±0.58	44.50±3.75	49.50±3.18	2.08±0.21
BM-60%	5.67±1.45	39.67±1.76	45.50±0.29	0.71±0.13	5.00±1.15	45.00±4.62	50.00±3.46	1.98±0.18
BM-80%	5.00±0.58	27.00±10.39	32.00±10.97	0.03±0.01	6.00±0.58	34.50±6.06	40.50±6.64	1.25±0.45
BM-100%	2.33±0.67	8.67±3.48	11.00±4.04	0.10±0.04	3.50±0.87	29.50±3.18	33.00±4.04	0.97±0.14
SM-40%	7.33±1.86	47.67±4.67	55.50±6.64	1.04±0.56	4.50±1.44	47.00±8.66	51.50±10.10	1.79±0.33
SM-60%	6.00±1.00	41.00±6.66	47.00±7.51	1.20±0.15	4.50±0.87	52.00±4.04	56.50±4.91	1.52±0.20
SM-80%	3.67±0.88	32.67±10.40	36.50±9.53	0.58±0.20	7.50±0.87	52.00±6.35	59.50±7.22	2.62±0.63
SM-100%	11.67±1.76	87.33±11.55	99.00±13.28	2.48±0.08	8.00±2.31	80.50±26.27	88.50±28.58	3.41±1.00
NM-40%	7.00±0.58	57.33±6.94	64.50±7.22	1.21±0.08	4.00±0.58	37.50±2.02	41.50±2.60	0.75±0.14
NM-60%	10.33±1.76	71.67±5.93	82.00±6.93	1.55±0.14	14.00±4.04	117.50±39.55	131.50±43.59	4.36±1.27
NM-80%	12.67±1.67	106.33±4.98	119.00±6.35	1.76±0.03	13.50±3.18	127.00±42.15	140.50±45.32	4.13±1.23
NM-100%	11.33±0.88	92.00±8.39	103.50±8.95	2.72±0.52	5.00±0.00	35.00±0.58	40.00±0.58	1.45±0.08

Fig.1 Effect of organic and plastic mulches on root development and root nodulation in cowpea

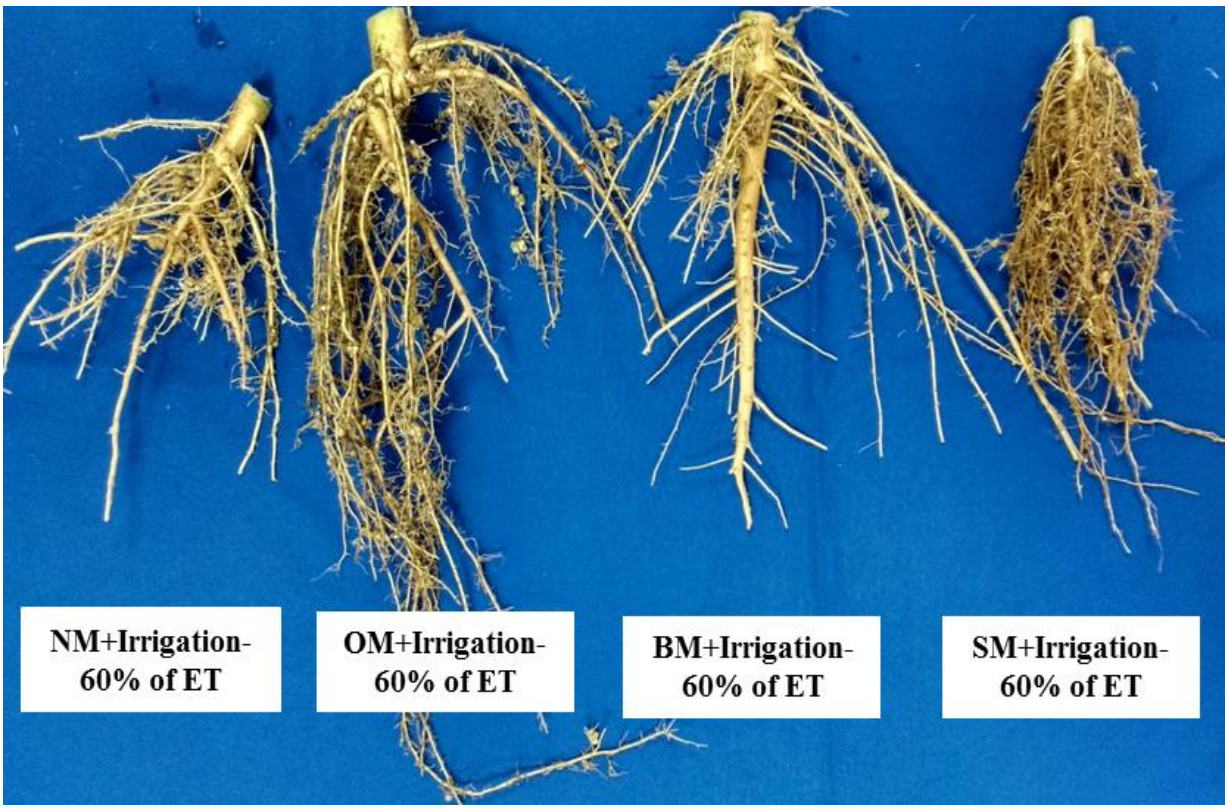


Fig.2 Effect of application of organic and plastic mulching on total root nodule weight observed after 60 days after sowing (DAS)

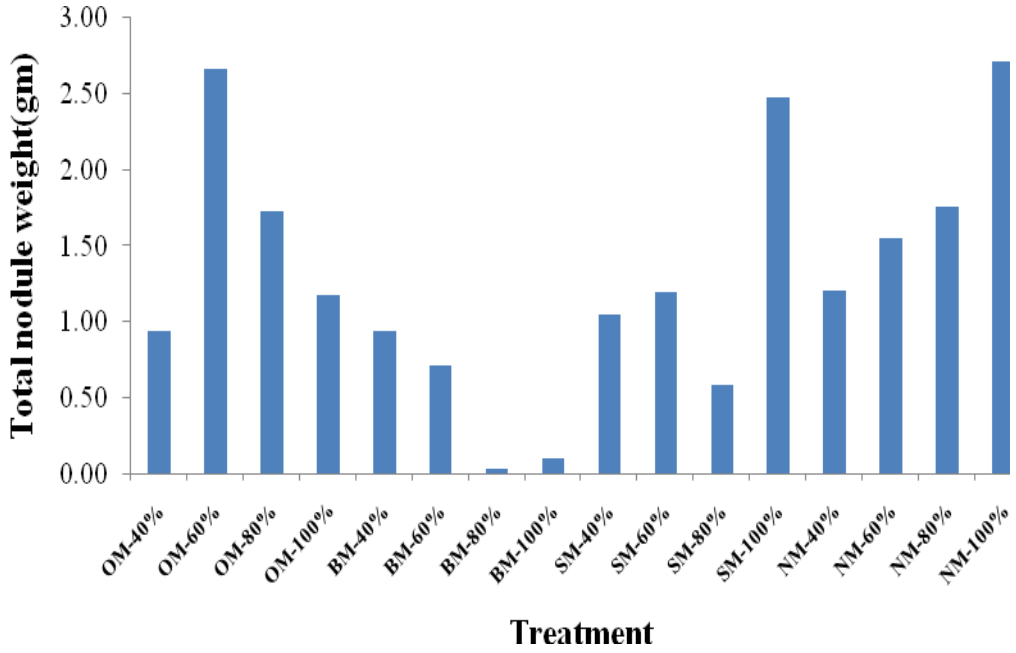
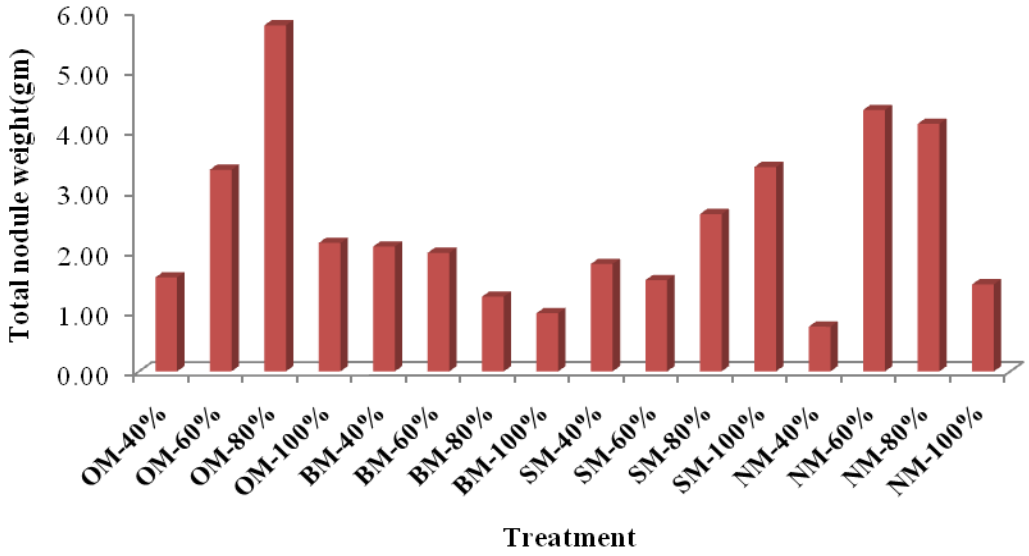


Fig.3 Effect of application of organic and plastic mulching on total root nodule weight observed after 90 days after sowing (DAS)



Total fresh root weight without nodules

At different crop stages of cowpea (60 DAS and 90 DAS), total weight fresh root without nodules was measured by detaching the individuals nodules from main and secondary roots (Table 2). At the end of 30 days growth stage, maximum weight fresh root without nodules (28.45 gm) was recorded in treatment involving organic mulch with irrigation applied at 100% of ET (OM-100%). It was significantly different from other treatments and the minimum observation (5.05gm) recorded treatment i.e., black mulch with irrigation applied at 80% of ET (BM-80%) The slightly similar trend was observed in observation recorded at the time of harvest (90DAS). At harvest stage, organic mulch with irrigation applied at 100% of ET (OM-100%) treatment recorded the maximum fresh root weight with nodules (38.22gm) which was significantly different from other treatment. No mulch treatment with irrigation applied at 100% of ET (NM-100%) recorded the minimum weight (8.12 gm) of fresh root with nodules at crop harvest stage.

Effect of application of organic and plastic mulching on root nodulation development in cowpea at different stages of crop growth

The experimental findings based on the study of effect of various mulching and drip irrigation on root nodulation parameters of cowpea such as number of root nodules per main root of plant, number of root nodules per secondary/lateral roots of plant, total number of root nodules per plant and fresh weight of total root nodule at 60 DAS and time of harvest stage (90 DAS).

Number of nodules per main root

The average number of secondary or lateral roots per plant of cowpea was recorded at 60 DAS, and at harvest stage (90DAS). At all different interval of crop growth stages, the number of secondary or lateral roots per plant differs significantly due to various treatments of organic and inorganic mulches and irrigation levels (Table 3; Figure 1). After 60 days of cowpea sowing, highest number of

root nodules per main root (12.67) was observed in treatment no mulch with irrigation applied at 100% of evapotranspiration (NM-100%) while lowest number of root nodules per main root (2.33) was observed in treatment involving black mulch with irrigation at 100 % of ET(BM-100%). At harvest stage (90 DAS), among various treatments of organic and plastic mulches, organic mulch with irrigation applied at 60% of ET (OM-60%) treatment recorded the highest number of root nodules per main root (17.00) which was significantly different than treatments black mulch with irrigation applied at 100% of ET (BM-100%) showing lowest number of root nodules per main root i.e., 3.50. Data obtained on cowpea root length in all other remaining treatments showed values in between this highest and lowest value recorded after 60DAS and 90 DAS.

Number of root nodules per secondary/lateral root

The number of nodules growing on secondary or lateral roots per plant of cowpea was recorded at 60 DAS and at harvest stage (90DAS) and analyzed statistically (Table 3). After 60 days of cowpea sowing, highest number of root nodules per secondary/lateral root (184.67) was observed in treatment organic mulch with irrigation applied at 60% of evapotranspiration (OM-100%) while lowest number of root nodules per secondary/lateral root (8.67) was observed in treatment involving black mulch with irrigation at 100 % of ET(BM-100%). At harvest stage (90 DAS), among various treatments of organic and plastic mulches, highest number of root nodules per secondary/lateral root (195.50) was observed in organic mulch with irrigation applied at 60% of ET (OM-60%) while lowest number of root nodules per secondary/lateral root (29.50) was found in treatment of black mulch with irrigation applied at 100% of ET (BM-100%). There was a significant difference in the highest and lowest value of data obtained for this parameter. Data obtained on cowpea root length in all other remaining treatments showed values in between this highest and lowest value recorded after 60 DAS and 90 DAS.

Total root nodules per plant

At different interval of crop growth stages, the total number of root nodules per plant grown under various treatments differed significantly due to application of various treatments of organic and inorganic mulches and different irrigation levels (Table 3). At 60 DAS, highest number of total nodule per plant (195.00) was recorded in treatment of organic mulch with irrigation applied at 60% of evapotranspiration (OM-100%) while lowest number of total root nodules per plant (11.00) was observed in treatment involving black mulch with irrigation at 100 % of ET(BM-100%). At the harvest stage (90 DAS), highest number of total root nodules per plant (211.00) was observed in organic mulch with irrigation applied at 80% of ET (OM-80%) while lowest number of total root nodules per plant (33.00) was found in treatment of black mulch with irrigation applied at 100% of ET (BM-100%). There was a significant difference in the highest and lowest value of data obtained for this parameter. Data obtained on this property in all other remaining treatments showed values in between this highest and lowest value recorded after 60 DAS and 90 DAS.

Fresh weight of total nodule plant

Fresh weight of total nodule obtained from main root and lateral roots of plant was measured at the end of 60 DAS and after harvest stage of crop growth was represented in Figure 2 and 3, respectively. At 60 days of

sowing (DAS), plants with highest fresh weight of total nodules root length (2.72gm) was observed in treatment no mulch with irrigation applied at 100% of evapotranspiration (NM-100%) while lowest fresh weight of total nodules of 0.03gm was observed in treatment involving black mulch with irrigation at 80% of ET(BM-80%). At harvest stage (90 DAS), among various treatments of organic and plastic mulches, organic mulch with irrigation applied at 80% of ET (OM-80%) treatment recorded the highest fresh weight of total nodules (5.77 gm) which was significantly different than treatments of no mulch with irrigation applied at 100% of ET (NM-100%) showing lowest fresh weight of total nodules i.e., 0.75 gm. Increased weight of root nodule in organic mulch treatment might be due to favourable effect of paddy straw organic mulch in improving the overall physical, chemical and biological attributes of the soil and thus improving root symbiosis process with soil nodule rhizobacteria thereby enhancing root nodulation activity of *Rhizobium* in the soil. Similar results were reported by Goud *et al.*, (2010) and Joshi *et al.*, 2016.

On the basis of the results obtained from the current study, it is clear that use of various organic and plastic/inorganic mulches has profound effects on root development and root nodulation in cowpea plants, however, application of different irrigation level has resulted in the variable type of findings. Among various treatments of organic and plastic mulches, organic mulches application has positive effects on most of the parameters associated with root development and nodulation, while it was negatively affected by black mulches. The type (organic or inorganic) and color and of the mulching materials are responsible for control microbiological properties in the soil (Moreno and Moreno, 2008). For example, increase in soil bacterial populations under organic mulches is due to different chemical compositions and degradation rates of organic materials applied in the form of straw, leaves, straw dust etc., (Mukherjee *et al.*, 1991). Contrary to this, the inorganic mulch applied in the form of plastic film residue decrease soil porosity and hence air movement in soil, which changes microbial communities and leads to low soil fertility (Yan *et al.*, 2010). Thus alteration in soil rhizobium population and communities due to changes in overall physical, chemical and biological attributes of soil owing to overlaying of mulches on soil surface might have affected the number, size, weight of nodule and overall nodulation in cowpea plants.

References

Abudulai, M., Seini, S. S., Haruna, M., Mohammed, A. M., and Asante, S. K. 2016. Farmer participatory pest management evaluations and variety selection in diagnostic farmer field Fora in cowpea in Ghana. *Afr. J. Agric. Res.*, 11:1765–1771.

Bhatt, L., Rana, R., Uniyal, S.P. and Singh, V.P. 2011. Effect of mulch materials on vegetative characters, yield and economics of summer squash (*Cucurbita pepo*) under rainfed mid-hill condition of Uttarakhand. *Veg. Sci.*, 38:165-168.

Bisikwa, J., Kawooya, R., Ssebuliba, J. M., Ddungu, S. P., Biruma, M., and Okello, D. K. 2014. Effects of plant density on the performance of local and elite cowpea varieties in Eastern Uganda. *Afr. J. Appl. Agric. Sci. Technol.*, 1: 28–41.

Ddamulira, G., Santos, C. A. F., Obuo, P., Alanyo, M., and Lwanga, C. K. 2015. Grain yield and protein content of Brazilian cowpea genotypes under diverse Ugandan environments. *Am. J. Plant Sci.*, 6: 2074–2084.

El Naim, A. M. and Jabereldar, A. A. 2010. Effect of Plant density and cultivar on growth and yield of cowpea (*Vigna unguiculata* L. Walp). *Australian Journal of Basic and Applied Sciences* 4: 3148-3153.

FAO. 2002. World Agriculture: towards 2015/2030. Summary report, Rome.

Goud, V. V., Kale, H. B. and Patil, A. N. 2010. Performance of organically grown mungbean under rainfed condition in vertisol. *J. of food leg*., 23: 218-222.

Hatami, S., A. Nourjou, M. Henareh and L. Pourakbar, 2012. Comparison effects of different methods of black plastic mulching and planting patterns on weed control, water-use efficiency and yield in tomato crops. Int. J. Agric. Sci., 2: 928-934.

Hoitink, H.A.J., Boehm, M.J., 1999. Biocontrol within the context of soil microbial communities: a substrate-dependent phenomenon. *Annu. Rev. Phytopathol.* 37: 427–446

Joshi, D., Gediya, K.M., Patel, J.S., Birari M.M., and Gupta, S. 2016. Effect of organic manures on growth and yield of summer cowpea [*Vigna unguiculata* (L.) Walp] under middle Gujarat conditions. *Agric. Sci. Digest.*, 36 (2):134-137

Moreno, M. M. and Moreno, A. 2008. Effect of different biodegradable and polyethylene mulches on soil properties and production in a tomato crop. *Sci. Hortic.* (Amsterdam) 116: 256–263.

Mukherjee, D., Mitra, S., and Das, A.C., 1991. Effect of organic matter cakes on changes in carbon, nitrogen and microbial population in soil. *J. Indian Soc. Soil Sci.* 39:121–126.

Robinson, D.W., 1988. Mulches and herbicides in ornamental plantings. *Hort. Sci.* 23:547–552.

Whitbread, A. and Lawrence, J. 2006. Cowpea fact sheet for Grain and Graze. Available online: White bread available on http://lwa.gov.au/files/products/grain-andgraze/ pn20434/pn20434.pdf.

Yan, C.R., He, W.Q. and Mei, X.R. 2010. Agricultural Application of Plastic Film and Its Residue Pollution Prevention. Science Press Beijing, China.

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