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RESEARCH ARTICLE :

Effect of foliar spray of water soluble fertilizers on total dry matter production (g plant^{-1}) nutrient uptake and economics in pigeonpea

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SUMMARY : The field experiment was conducted at College of Agriculture, Bijapur, toknow the effect of foliar spray of water soluble fertilizers on growth and yield of pigeonpea [*Cajanus cajan* (L.) Mill sp.] *Kharif*, 2013-14. The experiment was laid out with twelve treatments replicated thrice in Randomized Block Design. The data on total dry matter production of pigeonpea at harvest stage as influenced by foliar spray of water soluble fertilizers. Water soluble fertilizers had significant influences on total dry matter production at harvest.Significantly higher total dry matter production was recorded with the application of water soluble fertilizer 19:19:19 at 2% (142.7 g plant^{-1}) compared to all other treatments, except the foliar spray of 0:52:34 at 2% (129.1 g plant^{-1}). The lower total dry matter production was recorded in control (86.2 g plant^{-1}) compared to other treatments. foliar spray of 0:52:34 at 2% recorded higher uptake of nutrients (N, P and K) 128.3, 30.2, 45.3 kg ha^{-1}, respectively. Foliar spray of 19:19:19 at 2% recorded significantly higher net returns (Rs. 33,976 ha^{-1}) and it was followed by foliar spray of 0:52:34 at 2% (Rs. 28,518.78 ha^{-1}) Foliar spray of 19:19:19 at 2% recorded significantly higher B : C ratio (2.7) and it was on par with foliar spray of 0:52:34 @ 2% (2.5) and the least B : C ratio was recorded in foliar spray of 28:28:0 at 1% (1.7).

KEY WORDS :
Foliar spray, Pigeonpea, Dry matter, Nutrient

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BACKGROUND AND OBJECTIVES

Pigeonpea [*Cajanuscajan* (L.) Millsp.]is an annual shrub, sometimes perennial with longer duration. The growing period varies depending on cultivar and latitude.Pigeonpea is adapted to grow on fertile or infertile soils and has a low response to fertilizers. Pigeonpea is a major protein rich legume grown throughout the tropical and subtropical regions of the world between 30^0 N and 35^0 S latitudes. However, major area under pigeonpea in India is lying between 14^{0}S and 28^0 N latitudes, which occupy an area of about 4.09 m ha producing 3.27 m t with an average productivity of 799 kg ha^{-1} (Anonymous, 2011).Pigeonpea is cultivated for grain purpose as *dhal* which is a major

source of protein for poor farmers. It has three times protein as compared to cereals. Tender green seeds are used as vegetable, crushed seeds are used as animal feed, green leaves as fodder, stem is used as fuel wood, to thatch huts, for basket making, fencing and also used to culture the lac insects. It is often used as a live fence around small farms. It is grown across the mountain slopes to reduce soil erosion. Pigeonpea, like other pulses is considered as subsidiary crop. It is often grown on marginal lands and is usually intercropped with other pulses or planted on bunds. As a crop of secondary importance in many of these systems, it receives little or no purchased high cost inputs. However, in recent years, farmers are growing pigeonpea as a sole crop and the crop is increasingly gaining status as a cash crop especially in Gulbarga, Raichur, Bidar and Bijapur districts of Karnataka. It improves soil health through addition of leaf fall and its deep strong root system breaks the plough pans and improves the soil structure. Hence, pigeonpea is often called as a "biological plough". It can withstand drought for a longer period due to uncertainty and insufficient water availability and can be profitably cultivated as a gift crop by tail end farmers during *Rabi* season.

The low yield of pigeonpea is mainly attributed to its cultivation on poor soils with inadequate and imbalanced nutrient application without the application of organic manures. Since the poor soils are low in organic matter content, use of organic manures plays a vital role in improving soil physical condition, provides vital plant nutrients and maintains long term productivity of the soil. Agronomic practices of pigeonpea are required to be standardized for realizing yield potential. Among the different agronomic practices, foliar spray of macronutrients is most important factor in determining the yield (Malla Reddy *et al*., 2010). In almost all the pulses, flower drop determines the yield and yield attributing characters. Retention of flowers produced by the plant helps to get more yield than expected. The effect of foliar spray of 28:28:0 provides immediate nutrition to the crop during peak growth promotes the vegetative growth. Thus, helpful in giving the vigor to the crop, and also acts as yield booster, the foliar spray 0:52:34 provides vigor to crops when crop is facing adverse conditions like pest infestation and water stress. Foliar spray of 19:19:19 provides nutrients necessary for higher yield of pigeonpea and foliar spray of 0:0:50 for stronger growth of the crop.

According to several studies conducted in different crops by various scientists it is revealed that, retention of flowers is possible through foliar application of growth regulators as well as macronutrients during flower initiation stages. The present investigation planned to study the effect of foliar spray of macronutrients with 100 per cent recommended dose of fertilizers on growth, yield and economics of pigeonpea under rainfed conditions.

RESOURCES AND METHODS

A field experiment was carried out to study the "Effect of foliar spray of water soluble fertilizers on growth and yield of pigeonpea" [*Cajanuscajana* (L).Millsp]. During *Kharif* 2013-2014 under rained conditions at College of Agriculture, Bijapur. Located in the Northern Dry Zone of Karnataka and is situated at 16^0 49' North latitude, 75^0 43' East longitudes and at an altitude of 593.8 m above the mean sea level. The soil of the experimental site belongs to vertisols (medium deep black soils). Composite soil sample was collected at 0 to 30 cm depth from the experimental area before the layout. The soil samples were analyzed for physical and chemical properties.The soil is low in organic carbon status (0.42%), available nitrogen (223.7 kg ha^{-1}), available phosphorus (33.11 kg ha^{-1}) and medium in available potassium (295.50 kg ha^{-1}). The experiment was laid out in a RCBD design with three replications.The mean annual rainfall of the past 31 years (1981 to 2012) was 596.2 mm and it was distributed in 41 rainy days. Most of the rainfall was received from June to october (482.9 mm). September received maximum average rainfall of 149.5 mm followed by October (100 mm). April and May were the months of maximum air temperature which ranged from 38.60^0 C to 39.10^0 C, December and January were the coolest months with a mean monthly minimum temperature varying from 16.30^0 C to 16.20^0 C was recorded. The relative humidity during the year fluctuated between 42.9 per cent in March to 72 per cent during August. During the experimentation (2013-14), the total rainfall of 771.6 mm was received in 41 rainy days. The quantum of rainfall received during the period from May to of September was 613.3 mm and 158.3 mm was received during rest of the year. The good quality seeds of pigeonpea were sown at 5 cm the intra-row spacing of 90 cm inter row spacing 30 cm. Five competitive plants

selected were tagged at random from each plot for recording observations on various growth and yield parameters at peak flowering and pod developmentstage.

OBSERVATIONS AND ANALYSIS

The results summarized are given in Table 1 to 3.

The differences in the dry matter accumulation in leaves of pigeonpea as influenced by different treatment combinations were found significant. Significantly higher dry matter production on leaves was registered in the treatment receiving foliar spray of 19:19:19 at 2% (23.1 g plant^{-1}), and it was at par with foliar spray of 0:52:34 at 2% (20.4 g plant^{-1}), 13:0:45 at 2% (18.2 g plant^{-1}). Significantly lower dry matter production was recorded in control (13.6 g plant^{-1}) compared to other treatments. The dry matter production and its accumulation in leaves and stem were significantly higher with the foliar spray of 19:19:19 @ 2% (23.1) compared to other treatments. This is attributed to improvement in growth attributing

Table 1 : Dry matter accumulation in stem (g plant^{-1}), leaves and reproductive parts (g plant^{-1}) of pigeonpea at harvest as influenced by foliar spray of water soluble fertilizers

Treatments	Dry matter accumulation in stem (g plant^{-1})	Dry matter accumulation in leaves (g plant^{-1})	Dry matter accumulation in reproductive parts (g plant^{-1})	Total dry matter production (g plant^{-1})
T_1- Foliar spray of 19:19:19 @ 1%	22.9	15.4	56.8	95.1
T_2 - Foliar spray of 19:19:19 @ 2%	36.3	23.1	83.4	142.8
T_3 - Foliar spray of 28:28:0 @ 1%	22.1	14.3	67.3	103.7
T_4 - Foliar spray of 28:28:0 @ 2%	24.5	16.8	73.7	114.9
T_5 - Foliar spray of 13:0:45 @ 1%	22.7	14.3	54.1	91.1
T_6 - Foliar spray of 13:0:45 @ 2%	25.1	18.2	76.8	117.4
T_7 - Foliar spray of 0:52:34 @ 1%	22.1	15.4	73.1	110.4
T_8 - Foliar spray of 0:52:34 @ 2%	28.5	20.4	80.1	129.1
T_9 - Foliar spray of 0:0:50 @ 1%	21.2	15.9	59.2	97.0
T_{10} - Foliar spray of 0:0:50 @ 2%	21.9	20.6	74.1	116.2
T_{11} - Foliar spray of DAP @ 2%	21.7	15.3	59.4	96.4
T_{12} - Control (water spray)	19.1	13.6	51.5	86.2
S. E. ±	2.1	0.6	5.7	5.9
C. D. (P=0.05)	6.1	1.8	16.7	17.3

Note: Foliar spray of nutrients was done at peak flowering and pod development stage

Table 2 : Uptake of nitrogen, phosphorus and (kg ha^{-1}) by pigeonpea as influenced by foliar spray of water soluble fertilizers

Treatments	Nutrient uptake by pigeonpea at harvest stage		
	Nitrogen (kg ha^{1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
T_1- Foliar spray of 19:19:19 @ 1%	122.7	27.0	42.8
T_2 - Foliar spray of 19:19:19 @ 2%	126.3	25.4	43.0
T_3 - Foliar spray of 28:28:0 @ 1%	123.3	24.1	42.0
T_4 - Foliar spray of 28:28:0 @ 2%	125.7	25.3	42.7
T_5 - Foliar spray of 13:0:45 @ 1%	122.3	22.6	42.7
T_6 - Foliar spray of 13:0:45 @ 2%	125.0	26.0	44.3
T_7 - Foliar spray of 0:52:34 @ 1%	126.0	27.9	45.3
T_8 - Foliar spray of 0:52:34 @ 2%	128.3	30.2	44.3
T_9 - Foliar spray of 0:0:50 @ 1%	120.0	29.3	43.0
T_{10} - Foliar spray of 0:0:50 @ 2%	124.0	26.3	44.0
T_{11} - Foliar spray of DAP @ 2%	124.0	26.7	43.7
T_{12} - Control (water spray)	124.3	22.5	40.3
S. E. ±	2.8	1.0	1.0
C. D. (P=0.05)	NS	3.1	3.3

NS=Non-significant

characters like plant height, number of leaves and leaf area. These results are in accordance with Jagathjyothi *et al.*(2012).Dry matter accumulation in stem of pigeonpea differed significantly due to foliar application of various water soluble fertilizers Among the different treatments foliar spray of 19:19:19 at 2% recorded significantly higher dry matter accumulation in stem (36.3 g plant^{-1}), followed by foliar spray of 0:52:34 at 2% (28.5 g plant^{-1}) compared to all other treatments.Among the treatments, foliar spray of 19:19:19 at 2% recorded significantly higher dry matter accumulation in reproductive parts (83.4 g plant^{-1}) compared to all other treatments, except foliar spray of 0:52:34 at 2% (80.1 g plant^{-1}), 13:0:45 at 2% (76.8 g plant^{-1}), 0:0:50 at 2% (74.1

Table 3 : Cost of cultivation (Rs. ha^{-1}), gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and BC ratio of pigeonpea as influenced by foliar spray of water soluble fertilizers

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B C ratio
T_1- Foliar spray of 19:19:19 @ 1%	19168	35994	16826	1.9
T_2 - Foliar spray of 19:19:19 @ 2%	19455	53431	33976	2.8
T_3 - Foliar spray of 28:28:0 @ 1%	19533	33238	13706	1.7
T_4 - Foliar spray of 28:28:0 @ 2%	19733	39132	19400	1.10
T_5 - Foliar spray of 13:0:45 @ 1%	19227	33241	14014	1.7
T_6 - Foliar spray of 13:0:45 @ 2%	19436	42782	23346	2.2
T_7 - Foliar spray of 0:52:34 @ 1%	19303	35889	16586	1.9
T_8 - Foliar spray of 0:52:34 @ 2%	19518	48036	28518	2.5
T_9 - Foliar spray of 0:0:50 @ 1%	18958	36443	17485	1.9
T_{10} - Foliar spray of 0:0:50 @ 2%	19166	45811	26645	2.4
T_{11} - Foliar spray of DAP @ 2%	19423	34300	14877	1.8
T_{12} - Control (water spray)	15782	31738	15956	2.0

Note: Foliar spray of nutrients was done at peak flowering and pod development stage

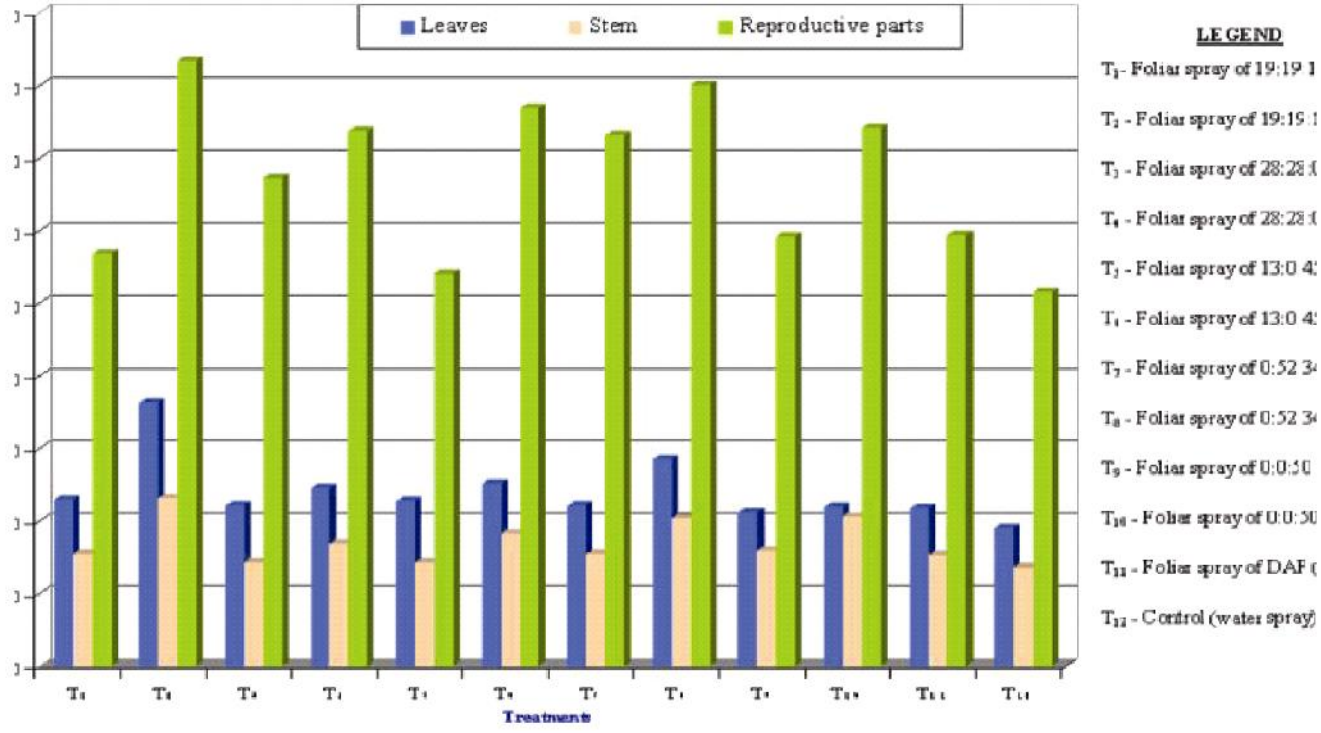

Fig. 1 : Total dry matter production and accumulation in stem, leaves and reproductive parts of pigeonpea

g plant^{-1}), 28:28:0 at 2% (73.1 g plant^{-1}), 0:52:34 at 1% (73.1 g plant^{-1}) and 28:28:0 at 1% (67.3 g plant^{-1}).The lower dry matter accumulation in reproductive parts was recorded in control where water spray was done (51.5 g plant^{-1}).The results indicated that the significant effect of foliar spray of water soluble fertilizers on The total dry matter per plant was significantly higher with the foliar spray of 19:19:19 @ 2% at harvest (142.8 g plant^{-1}) and was followed by foliar spray of 13:0:45 @ 2 (117.4 g plant^{-1}).At harvest, significantly higher amount of dry matter was accumulated in the reproductive parts with foliar spray of 19:19:19 @ 2% (83.4 g plant^{-1}) and 0:52:34 at 2% (80.1 g plant^{-1}).The increase in leaf dry matter may be due to higher leaf area and leaf area index recorded with the foliar spray of 19:19:19 @ 2%. This resulted in higher assimilatory surface area which might have helped in the development of efficient photosynthetic system with better availability of nutrients to put forth higher dry matter in leaves. Significant increase in leaf area could be due to increased metabolic activity by increased supply of nutrients which ultimately increased leaf count per plant. Foliar spray of 19:19:19 @ 2% to pigeonpea had a favorable effect on dry matter accumulation in leaves over other treatments. Similar results of increased growth parameters with foliar spray of nutrients were reported by Premsekhar and Rajashree (2009).Foliar spray of 0:52:34 at 2% recorded higher uptake of nutrients (N, P and K) 128.3, 30.2, 45.3 kg ha^{-1}, respectively Similar results were reported by Yadav and Choudhary (2012) in Cowpea. Higher availability of nutrients with the foliar spray of 13:0:45 at 1% resulted in higher uptake of nutrients which led to lower available nitrogen; phosphorus and potassium in soil Similar results were also reported by Gupta *et al.*, 2011.There was no significant difference between the treatments in uptake of N by pigeonpea due to the foliar application of various water soluble fertilizers.Phosphorus uptake by pigeonpea differed significantly due to foliar spray of water soluble fertilizers. Among the treatments foliar spray of 0:52:34 at 2% recorded significantly higher uptake of phosphorus (30.2 kg ha^{-1}) followed by foliar spray of 0:52:34 at 1% (27.9 kg ha^{-1}) and it was on par with foliar spray of 0:0:50 at 2% (26.3 kg ha^{-1}), 13:0:45 at 2% (26.0 kg ha^{-1}) and foliar spray of DAP at 2% but lower uptake of phosphorus (22.5 kg ha^{-1}) was recorded with foliar spray of 28:28:0 at 2%.There was significant difference with respect to uptake of potassium by pigeonpea with foliar spray of various water soluble fertilizers. Among the treatments foliar spray of 0:52:34 at 2% recorded higher uptake of potassium (45.3 kg ha^{-1}), followed by foliar spray of 0:52:34 at 1% (44.3 kg ha^{-1}) and it was on par with foliar spray of 0:0:50 at 2% (44.0 kg ha^{-1}), 13:0:45 at 2% (43.6 kg ha^{-1}), foliar spray of DAP at 2% (43.6 kg ha^{-1}) compared to water spray control (40.3 kg ha^{-1}). Economics is the final criteria to evaluate the best treatment which is economically sound and can be accepted by the farming community. Among the different indicators of economic efficiency in any production system, net returns have greater impact on the practical utility and acceptance of the production technology by the farmers. The cost of cultivation differed significantly with foliar application water soluble fertilizers. Foliar spray of 19:19:19 @ 2% recorded higher cost of cultivation (19733 ha^{-1}) and which was followed by 28:28:0 @% (19533 ha^{-1}). Whereas lower cost of cultivation was recorded in water spray control (Rs. 31738.00 ha^{-1}).Foliar spray of 19:19:19 at 2% recorded significantly higher net returns (Rs. 33976 ha^{-1}) and which was followed by 0:52:34 @ 2% (Rs. 28518.78 ha^{-1}).Whereas, lower gross returns was recorded in no foliar spray control (15956.) Foliar spray of 19:19:19 at 2% recorded significantly higher BC ratio (2.7) and it was followed by foliar spray of 0:52:34 at 2% (2.5) and 0:52:34 at 2% (2.4) however, the lower BC ratio was recorded with foliar spray of 28:28:0 at 1% (1.7)

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