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Impact of foliar application of primary nutrients on growth and yield contributing traits in cashew (*Anacardium occidentale* L.)

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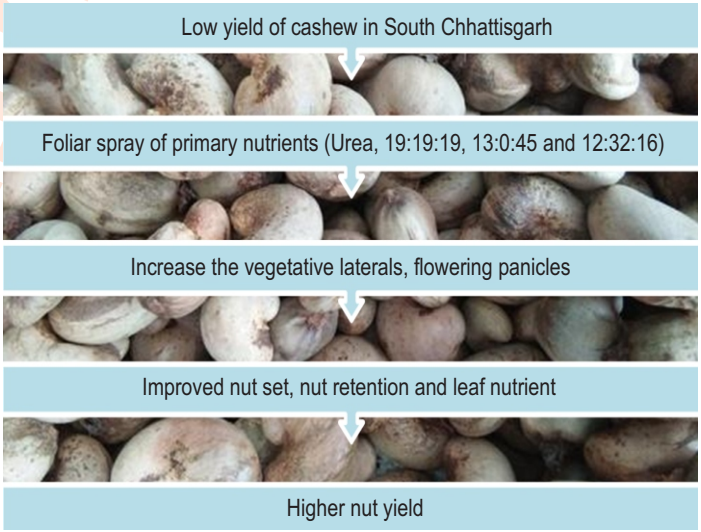
Abstract

Aim: To find suitable fertilizer and concentration for foliar application in cashew to improve fruit retention, nut yield and leaf nutrient content in South Chhattisgarh region.

Methodology: An on-farm trial were conducted consecutively for three years from 2017-18 to 2019-20 to study the response of cashew trees to foliar application of major nutrients with respect to growth and yield attributes. The fertilizers selected for foliar application were NPK (19-19-19), Urea, NPK (13-0-45) and NPK (12-32-16) at 1 and 2 % along with non-sprayed trees as control. All the treatments were imposed in three replications under RBD design. The age of selected trees was 15 years.

Results: Foliar spray of 2% Urea before the vegetative flush, after the vegetative flush and nut set stage gave significantly higher mean number of flowering panicles m^{-2}, number of nuts at pea nut and marble stage, high fruit retention, more number of nuts per panicle, nut yield per tree, weight of 100 nuts and maximum leaf nutrient content at flowering and harvesting stages.

Interpretation: Foliar application of fertilizers with primary nutrients lead to significant improvement in flowering, fruit set and leaf nutrient content, which may influence nut yield in cashew.



Key words: Cashew, Flowering, Foliar nutrient, Nut yield, Water soluble fertilizers

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Introduction

In India, cashew was first introduced to the Malabar Coast from where the horizon extended to other coastal areas, southern part and the Andaman Islands of the country (Preethi *et al.,* 2021). Currently, cashew is being cultivated in Maharashtra, Goa, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and Kerala. The crop is now being cultivated in non-traditional states like Chhattisgarh, Gujarat, Assam, Arunachal Pradesh, Meghalaya, Tripura, Manipur, Nagaland and Andaman and Nicobar Islands. In the beginning, it was mainly a crop for afforestation and soil binding to check erosion but now it is one of the dollars earning crop. The raw cashew nut production during the year 2018-19 was 8.17 lakh million tonnes in an area of 10.62 lakh ha with productivity of 753 kg ha^{-1} (DCCD, 2019). Cultivation of cashew in India is pertained to coastal regions specifically to the east coast, west coast and sub-humid Deccan plateaus. Cashew cultivation in Chhattisgarh was started with the objective to increase the area and production of plantation crops. During the year 2016-17, the area under cashew in Chhattisgarh was 13.70 thousand ha with production of 9.33 lakh tonnes (Ramteke *et al.,* 2020).

Even though cashew tree produces profuse flowers every season, fruit set is reported to be as low as 1-2 %. The poorly nourished soil and coarse texture of the plateau region is mainly concerned with heavy flower and fruit drop in cashew (Saroj, 2015). This will eventually lead to low yield and poor quality nuts. Cashew being a regular bearer which puts forth flowering and sets fruits on the current season flush, the plant requires adequate nutrients for production of new flowers, fruit set and production of quality nuts. Nutrients have beneficial effect on flower initiation, fruit set and development, nut yield, quality kernel and shell (Yamakanamardi *et al.,* 2020). According to research conducted in various fruit crops, foliar application of nutrition appears to have a beneficial impact on yield and quality (Gawankar *et al.,* 2010; Jat and Kacha, 2014; Gajbhiye *et al.,* 2015; Yamakanamardi *et al.,* 2020). Basal application of fertilizers during monsoon is not completely utilized by the crop and lost via leaching, fixation and other processes, leaving the crop vulnerable to nutrient deficiency. As a result, supplementary foliar spray is one of the means to enhance the crop performance through fertilizer or nutrient use efficiency. In pulses and oilseeds, nutrients applied by foliage play a crucial role in increasing plant growth and yield (Chandrasekhar and Bangarusamy, 2003).

Supplemental foliar nutrients are more efficient than soil application because nutrients are more effectively adsorbed by leaves through phloem tissues (Manonmani and Srimathi, 2009). Nutrients applied through foliages are targeted directly towards the synthesis of photoassimilates, accelerating its supply without waste, which eventually increases the fertilizer use efficiency. Cashew tree responds well to nutrient application, though the results vary greatly depending on tree age, genotype, cultivation, soil and environmental conditions, as well as several other factors (Vanlauwe *et al.,* 2002). Young cashew plants react well to nitrogen and phosphate application, but during bearing stage, potash in conjunction with nitrogen is most essential (Marscgner, 1995). Nitrogen, phosphorus and potassium are the essential nutrients for plant growth and development. Nitrogen is present in amino acids, proteins, nucleic acids, porphyrins, purines and pyrimidine nucleotides, flavin nucleotides, enzymes, co-enzymes and alkaloids. Energy transmission, photosynthetic operation, sugar and starch conversion, nutrient transport within the plant, and the transfer of hereditary traits from one generation to another are all dependent on phosphorus. Potassium is necessary for transporting water and nutrients in the plant's xylem. It encourages root growth and improves drought resistance as well as activates and synthesizes the protein-forming nitrate reductase enzyme (Rattan and Goswami, 2009).

Since urea penetrates the cuticle 10 to 20 times better than inorganic ions, it is considered the best source of nitrogen to apply as a foliar spray (Khan *et al.*, 2009; Ding *et al.*, 2020). Fertilizer NPK 19-19-19 is a 100 % water soluble fertilizer that contains nitrogen in three forms: NO_3-N (45.0%), NH_4-N (4.5%), and NH_2-N (10.5%), as well as water soluble phosphorus and potassium, each of which contains 19 % and has a low salt index. It improves pest and disease tolerance by keeping plants healthy, resulting in lesser need of agrochemicals and more uniform flowering with little droppings, leading to higher crop yield (Yawalkar *et al.,* 1996). Fertilizer NPK 13-0-45 contains nitrate and potash which helps in assimilation, translocation and formation of sugars which attributes to yield and quality fruits. Similarly, fertilizer 12:32:16 contains all three major nutrients essential for luxury growth of plants. Among the many constraints to cashew yield, nutrition plays an important role in increasing cashew nut production. Cashew tree extracts a substantial portion of nutrients from the soil each year. Fruit set response is attributed to plant hormone activity in a more ambiguous way to nutrition (Mengel *et al.,* 2001). While cashew is also being cultivated in fairly traditional regions of South Chhattisgarh, no attempt has been made to investigate the impact of foliar nutrient application on its growth and yield characteristics. As cashew is more responsive crop to foliar nutrient application, the present research investigates the effect of foliar nutrient application on cashew variety Vengurle-4.

Materials and Methods

Experimental site and location: The experiment was carried out at Cashew Experimental Block, All India Coordinated Research Project on Cashew, Research cum Instructional Farm, Shaheed Gundadhur College of Agriculture and Research Station, Kumhrawand, Jagdalpur, Chhattisgarh (India) during flowering and fruiting seasons 2017-18, 2018-19 and 2019-20. The experimental site at Kumhrawand village is situated 543 m above mean sea level at 18.53 ºN latitude and 81.57 ºE longitudes. The average annual rainfall is 1404 mm, with more than 80% falling between July to September.

Soil conditions: The soil at the experimental site was yellow-red silt loam (Inceptisol) with a pH 6.3, electrical conductivity 0.13

dsm^{-1}, and organic carbon 1.03 %. The available nitrogen, phosphorous and potassium in the experimental site was estimated and falls under the category of low (185.62 kg N ha^{-1}), high (24.45 kg of P ha^{-1}) and medium (219.82 kg of K ha^{-1}), respectively.

Experimental setup: The study was carried out in 15-year-old cashew plantation (variety Vengurle-4) planted at 7 m x 7 m spacing. The experiment consist of 9 treatments and 3 replications in a randomized block design. The treatments consist of fertilizers 19:19:19, Urea, 13:0:45, 12:32:16 and no spray (control). Every fertilizer in the treatments was tried with two concentrations *i.e.,* 1% and 2%. Foliar spray of fertilizers were applied at three different growth stages *viz.,* before vegetative flush, after vegetative flush and nut set stage. For imposing treatments, a group of eighteen trees having uniform size and canopy were selected for each replication. Each treatment was performed on two different trees within the replication. In total, 54 trees were selected for the study, which included three replications. Crop cultivation and plant protection measures were implemented as per the recommended package of practices.

Observations on growth, flowering and yield parameters: The growth, flowering and yield attributes was recorded by following the standard procedure described by Thimmappaiah *et al.* (2005). A square iron frame measuring one meter was used to count the number of laterals from a one-square-meter canopy area in four directions. The number of days between the first and last day of flowering was used to calculate the duration of flowering. The sex ratio was determined by selecting and tagging four panicles from each observational tree. The number of perfect flowers and staminate flowers appearing in each of the four tagged panicles were counted on alternate days and the counted flowers were removed from the panicles. The ratio between staminate and hermaphrodite flowers was determined following the method developed by Hassan *et al.* (1988).

Estimation of leaf nutrient content: The treatment wise leaf samples were collected at five stages *viz.,* before vegetative flush, after vegetative flush, flowering, nut setting and after harvest from all directions and dried at 60°C, which were used for chemical analysis (Gavit *et al.,* 2017). Prior to spraying, leaf samples were obtained using the standard protocol. Plant samples were digested in diacid mixture (Nitric acid: Perchloric acid in proportion 9:4) and extract after filtration was used to estimate macronutrients, except for nitrogen. The total nitrogen content of the plant sample was calculated following the micro-Kjeldahl technique (Tandon, 1993). To determine phosphorus and potassium content, one gram of plant samples was digested in nitric and perchloric acid solution the phosphorus, the final volume was made to 100 ml with distilled water and and potassium content in the extract was determined (Singh *et al.,* 1999).

Statistical analyses: The mean data of three seasons, *i.e.,* 2017-18, 2018-19 and 2019-20 were subject to pooled analysis of variance. The data obtained were analyzed statistically as per method described by Gomez and Gomez (1984) and were tested at 5% level of significance (P=0.05) to interpret significant difference using OPSTAT software (Sheron *et al.,* 1998).

Results and Discussion

Foliar application of water soluble fertilizers has a significant effect on altering the tree physiology to increase the flowering laterals. Among the fertilizers used, spraying of NPK 13-0-45 at 2% concentration increased the number of laterals from 27.54 m^{-2} to 32.46 m^{-2}. The fertilizer 13:0:45 at 1% concentration was also observed for effective production of new laterals. Trees sprayed with fertilizer NPK 12-32-16 and without spray recorded the least number of laterals compared to their respective before sprayed trees (Table 1). Cashew put forth flowers in the current season shoot (Preethi *et al.,* 2021), hence, increase in one or few number of new laterals positively affects the yield. Nitrogen is an

Table 1: Effect of foliar application of fertilizers on production of present season laterals in cashew

Treatments	No. of laterals m^{-2} before spray	No. of laterals m^{-2} after spray	No of laterals increased due to foliar spray	Percentage increase in laterals
NPK 19-19-19 at 1%	26.76	28.67^{ef}	1.91^{ef}	7.14^{ef}
NPK 19-19-19 at 2%	27.82	31.14^{c}	3.32^{c}	11.93^{c}
Urea at 1%	27.56	29.78^{de}	2.22^{de}	8.06^{de}
Urea at 2%	26.67	29.12^{d}	2.45^{d}	9.19^{d}
NPK 13-0-45 at 1%	26.41	30.17^{b}	3.76^{b}	14.24^{b}
NPK 13-0-45 at 2%	27.54	32.46^{a}	4.92^{a}	17.86^{a}
NPK 12-32-16 at 1%	25.34	26.78^{h}	1.44^{h}	5.68^{h}
NPK 12-32-16 at 2%	26.16	28.19^{fg}	2.03^{fg}	7.76^{fg}
Control	27.23	28.45^{h}	4.48^{h}	4.48^{h}
Sem ±	0.76	1.62	1.80	1.80
C.D. (p=0.05)	NS	4.73	5.33	5.33

The values are pooled mean of consequent three years, NPK reflects the available nitrogen, phosphorous and potassium in the fertilizer by weight, values with different alphabets are significantly different at 5% level, values without or same alphabets are not significantly different at 5% level, NS: Non significant

Table 2: Effect of foliar application of fertilizers on flowering attributes of cashew

Treatments	No. of flowering panicles m^{-2}	Flowering duration (days)	No. of flowers per panicles	No. of staminate flowers per panicles	No. of hermaphrodite flowers per panicles	Sex ratio (hermaphrodite: staminate)
NPK 19-19-19 at 1%	15.51^{e}	110.27	472.90^{d}	410.12^{f}	62.78^{b}	0.15^{b}
NPK 19-19-19 at 2%	16.71^{b}	109.45	383.64^{e}	326.21^{g}	57.43^{c}	0.18^{a}
Urea at 1%	17.21^{b}	109.76	366.93^{e}	325.23^{g}	41.70^{d}	0.13^{c}
Urea at 2%	17.85^{a}	112.78	535.40^{cd}	489.62^{cd}	45.78^{d}	0.09^{de}
NPK 13-0-45 at 1%	15.76^{de}	108.67	681.41^{a}	629.63^{a}	51.78^{cd}	0.08^{e}
NPK 13-0-45 at 2%	16.41^{bc}	104.56	592.12^{ba}	528.23^{c}	63.89^{b}	0.13^{c}
NPK 12-32-16 at 1%	15.34^{ef}	103.76	671.14^{a}	602.23^{ab}	68.91^{b}	0.11^{d}
NPK 12-32-16 at 2%	15.98^{d}	105.76	655.17^{a}	567.89^{bc}	87.28^{a}	0.15^{b}
Control	15.12^{g}	101.56	480.01^{d}	456.45^{e}	23.56^{e}	0.05^{f}
SEm±	0.48	1.88	47.34	40.40	15.32	0.02
C.D. (p=0.05)	1.41	NS	140.80	121.2	45.40	0.07

The values are pooled mean of consequent three years, NPK reflects the available nitrogen, phosphorous and potassium in the fertilizer by weight, values with different alphabets are significantly different at 5% level, values without or same alphabets are not significantly different at 5% level, NS: Non significant

important nutrient that initiates new flush and chlorophyll synthesis whereas auxin helps in the development of vegetative shoots (Afiqah *et al.,* 2014). Though nitrogen is responsible for initiation and development of vegetative shoots, NPK 13-0-45 which has lesser nitrogen content (13% N) compared to NPK 19-19-19 (19% N) and Urea (46 % N), performed well in both the concentrations. This may be due to the presence of potassium in association with nitrogen fertilizer as potassium is responsible for translocation of water, nutrients and photo assimilates in the plant system (Ragel *et al.,* 2019). Hence, NPK 13-0-45 fertilizer was recorded for its significance in lateral production irrespective of their concentration.

Another set of water soluble fertilizer applied as a foliar spray in cashew also increased the lateral production in cashew (Gajbhiye *et al.,* 2015). Foliar spray of 2% Urea increased the number of flowering panicles m^{-2} followed by 1% Urea and trees without spray (control) recorded least number of flowering panicles m^{-2} (Table 2). The production of flowering shoots or panicles depends on the photoperiodism and nutrients received by the plant system (Wilkie *et al.,* 2008). Foliar application of 2% Urea may improve the accumulation of photo assimilates by increasing the leaf area or number, which intercepts more radiant energy and enhances plant capacity to use available nutrients and net photosynthesis when compared with control. It was observed that the increasing nitrogen content in fertilizers effectively increases the number of flowering panicles at 2% concentration. But, except urea, other fertilizers at 1% concentration had a similar effect on the production of flowering panicles invariable to their nitrogen content. These results are in close conformity with the findings of Gawankar *et al.* (2010) and Gajbhiye *et al.* (2015) who observed higher number of flowering panicles due to foliar spray of urea in cashew. The flowering duration in cashew was not effectively affected with respect to the application of foliar nutrients. Though application of 2% Urea extended the flowering duration, the effect of nutrients and their combinations on flowering duration is ambiguous. Cashew is a highly cross pollinated crop, hence the number of flowers either male or perfect flowers play a vital role in determining the nut yield. NPK 13-0-45 and NPK 12-32-16 increased the number of flower in a panicle irrespective of their concentrations followed by NPK 19-19-19, Urea and control.

The performance of NPK 13-0-45 and NPK 12-32-16 on increasing the staminate and hermaphrodite flower numbers was also observed (Table 2). The results indicate that the presence of potassium and phosphorous in the fertilizers potentially increased the staminate and hermaphrodite flowers in cashew. Potassium is a potential bud-breaking agent used in many of the temperate fruit crops, it accelerates fruit bud differentiation in dormant buds and there by flowering (Feucht, 1982). Phosphorous also encourages the absorption of magnesium, an element that is essential in the floral formation and promotes synthesis of nucleic acids in buds (Augusti, 2003). Hence, both the nutrients have a greater role in increasing the flower count per unit. When complex fertilizers and urea were used as a foliar spray in cashew, similar kind of results were obtained by Gawankar *et al.* (2010) and Gajbhiye *et al.* (2015) with respect to staminate, hermaphrodite and total number of flowers. The foliar application of water soluble fertilizers increased the nut set rate at pea, marble and harvest stages as well as fruit retention per cent in cashew.

The application of 2% Urea maximized the nut count at peanut, marble and harvestable stage followed by application of 1% Urea. Similar influence was observed on fruit retention due to foliar spray of 2% and 1% Urea, NPK 19-19-19 at 1%. Hence, the subsequent nut yield was recorded highest in 2% Urea followed by NPK 19-19-19 at 1%. The increased nut set as a result of urea spray irrespective of concentration and NPK 19-19-19 may be because of higher nitrogen content. Nitrogen is an essential

Table 3: Effect of foliar application of fertilizers on yield and quality attributes of cashew nut and apple

Treatments	Number of nuts per panicle at pea nut stage	Number of nuts per panicle at marble stage	Number of nuts per panicle at harvest stage	Fruit retention (%)	Yield (kg tree^{-1})	Weight of 100 nuts (g)	Apple weight (g)	Shelling (%)
NPK 19-19-19 at 1%	25.65^{c}	13.45^{cd}	8.34^{d}	32.51^{c}	5.82^{c}	698.56^{d}	65.17	29.41
NPK 19-19-19 at 2%	26.40^{b}	14.10^{cd}	9.42^{b}	35.68^{a}	6.12^{b}	723.78^{a}	67.89	29.56
Urea at 1%	27.10^{ab}	15.25^{b}	9.56^{b}	35.28^{a}	5.91^{c}	702.31^{c}	63.78	29.18
Urea at 2%	28.20^{a}	16.40^{a}	10.87^{a}	38.55^{a}	6.56^{a}	710.27^{b}	66.45	29.76
NPK 13-0-45 at 1%	24.61^{d}	12.06^{e}	7.84^{f}	31.86^{d}	5.25^{de}	692.35^{ef}	63.45	29.67
NPK 13-0-45 at 2%	25.48^{c}	13.38^{d}	8.12^{e}	31.87^{d}	5.34^{d}	698.67^{d}	64.67	29.41
NPK 12-32-16 at 1%	23.72^{e}	12.24^{e}	7.28^{g}	30.69^{e}	5.09^{e}	684.56^{g}	66.32	29.34
NPK 12-32-16 at 2%	24.56^{d}	14.89^{c}	8.64^{c}	35.18^{bc}	5.74^{cd}	693.74^{e}	68.13	29.45
Control	21.12^{f}	10.10^{f}	6.60^{h}	31.25^{d}	4.23^{f}	669.41^{h}	61.98	29.56
SEm±	0.73	0.61	0.18	0.84	0.45	8.54	3.42	0.62
C.D. (p=0.05)	2.14	1.76	0.55	2.41	1.26	24.21	NS	NS

Values are pooled mean of consequent three years, NPK reflects the available nitrogen, phosphorous and potassium in the fertilizer by weight, values with different alphabets are significantly different at 5% level, values without or same alphabets are not significantly different at 5% level, NS: Non significant

Table 4: Effect of foliar sprays of fertilizers on nitrogen, phosphorous and potassium content of cashew leaves

Treatments	Nitrogen (%)		Phosphorous (%)		Potassium (%)	
	Flowering stage	Harvesting stage	Flowering stage	Harvesting stage	Flowering stage	Harvesting stage
NPK 19-19-19 at 1%	1.718^{c}	1.680^{c}	0.083^{c}	0.069^{c}	0.570^{b}	0.546^{bc}
NPK 19-19-19 at 2%	1.729^{c}	1.694^{c}	0.088^{b}	0.071^{c}	0.574^{b}	0.550^{a}
Urea at 1%	1.786^{b}	1.712^{b}	0.073^{de}	0.056^{de}	0.548^{bc}	0.531^{d}
Urea at 2%	1.897^{a}	1.746^{a}	0.075^{d}	0.060^{d}	0.559^{bc}	0.544^{c}
NPK 13-0-45 at 1%	1.712^{c}	1.678^{c}	0.071^{e}	0.056^{de}	0.591^{a}	0.567^{a}
NPK 13-0-45 at 2%	1.732^{c}	1.687^{c}	0.073^{de}	0.054^{e}	0.613^{a}	0.584^{a}
NPK 12-32-16 at 1%	1.679^{d}	1.607^{d}	0.091^{a}	0.074^{b}	0.569^{bc}	0.547^{bc}
NPK 12-32-16 at 2%	1.711^{c}	1.674^{c}	0.093^{a}	0.077^{a}	0.572^{b}	0.550^{a}
Control	1.540^{e}	1.381^{e}	0.067^{f}	0.043^{f}	0.450^{d}	0.435^{e}
SEm±	0.027	0.027	0.002	0.002	0.028	0.018
C.D. (p=0.05)	0.081	0.083	0.006	0.006	0.087	0.059

Values are pooled mean of consequent three years, NPK reflects the available nitrogen, phosphorous and potassium in the fertilizer by weight, values with different alphabets are significantly different at 5% level, values without or same alphabets are not significantly different at 5% level, NS: Non

component of protoplasm and is helpful in chlorophyll synthesis, and thus increases photosynthesis and consequently urea enhances the synthesis of endogenous hormones (Yu *et al.,* 2019). Yamakanamardi *et al.* (2020) obtained increased fruit set and yield in cashew due to foliar application of nitrogen source fertilizer. As nitrogen might have benefited fruit set by enhancing pollen germination or assisting the growth of pollen tubes, allowing for timely fertilization before the stigma lost its receptivity or style became non-functional. Similarly, significant fruit set and yield increase was observed in guava (Jat and Kacha, 2014). The same reason might have been attributed for higher retention of nuts and yield increase in cashew owing to as foliar spray of urea. The foliar spray of nutrients significantly influenced the weight of 100 nuts whereas apple weight and shelling per cent were not regulated by application of foliar nutrients. The highest weight of 100 nuts was recorded in NPK 19-19-19 at 2% followed by Urea at 2% owing to increased nut weight in these treatments. The residual affect of adsorbed nutrients like N, P and K during flowering and fruit set phase would have been deposited in the storage tissues, which subsequently act as a resource material for nut development and maturity (Yamakanamardi *et al.,* 2020).

In the present findings, Urea and NPK 19-19-19 were more effective in increasing the nut yield, because of their action in increasing the nut set at pea and marble stage, fruit retention and number of nuts per panicle. The enhanced nut yield in cashew due to Urea spray has also been reported by Sapkal *et al.* (2000). Better retention of nuts would have also been facilitated

the higher adsorption of nutrients and subsequently enhances the utilization of nutritional resources within the tree resulting in maximum yield (Kumar and Reddy, 2008). Foliar nutrient application significantly influenced the leaf nutrients in cashew at flowering as well as harvesting stages invariable to the water soluble fertilizers and their concentrations used in this experiment (Table 4). The highest nitrogen content in cashew leaves was recorded on spraying 2% Urea at both flowering and harvesting stage. It was observed that the fertilizers NPK 12-32-16 and NPK 19-19-19, where phosphorous is one of the major component, increased leaf phosphorous content at both flowering and harvest stages.

The highest leaf potassium content was recorded in cashew trees applied with NPK 13-0-45 followed by NPK 19-19-19 and NPK 12-32-16. The results of this experiment clearly indicate that the N, P, K content and their concentrations in the fertilizers were reflected proportionately in leaf nutrient content at flower set and harvest stages. Palsande *et al.* (2013) and Gavit *et al.* (2017) observed similar results in cashew sprayed with primary nutrients with respect to N, P and K content in leaves. The increased supply of major nutrients through foliar spray may trigger their absorption directly through phloem, resulting in higher nutrient content in leaves of treated cashew trees (Nanthakumar *et al.,* 1997). The gradual reduction in leaf nutrient content was observed over the nut growth and maturation stage, regardless fertilizers and their spray concentration, which may be resulted due to the translocation of ionic substances to the developing nuts (Babu *et al.,* 2010). Foliar fertilization promotes leaf activity, which triggers water absorption by the plant's vascular system, thereby increasing nutrient uptake from the soil. Nutrient foliar spray facilitated the timely supply of nutrients in adequate quantities to plants which significantly increases leaf nutrient content and fruit yield (Ullasa *et al.,* 2016).

The importance of plant nutrition in yield enhancement and quality upgradation has been widely emphasized in many crops. Each element has its own importance in plant growth and development and there is a direct relationship of leaf nutrients with yield and quality of fruits. Thus, it can be concluded from the findings of the present study, that the foliar application of Urea at 2% before and after the vegetative flush, nut set stages improves the fruit retention, nut yield and leaf nitrogen content of cashew trees. Therefore, in the Bastar region, the foliar application of Urea at 2% with recommended basal dose of fertilizer has pronounced effect in improving tree growth and nut yield than other fertilization approaches in cashew.

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Add-on Information

Authors' contribution: V. Ramteke: Conceptualized the experiment, Data collection and Manuscript preparation; **P. Preethi:** Manuscript preparation, review and editing; **G.L. Veena:** Manuscript review and editing; **Y.S. Nirala:** Manuscript preparation.

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