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Research Paper

# Effect of nitrogen and phosphorus fertilization along with foliar spray of calcium chloride and potassium nitrate on performance of cowpea (*Vigna unguiculata*) + baby corn (*Zea mays*) intercropping systems

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## ABSTRACT

An field experiment was carried out during 2019 and 2020 at Agriculture Research Station, Ummedganj, Kota, Rajasthan, to study the effect of NP fertilization and foliar spray of stress-mitigating chemicals on yield attributes and yields of cowpea [*Vigna unguiculata* (L.) Walp.] and baby corn (*Zea mays* L.) in cowpea and baby corn cropping system. The experiment was laid out in split split-plot design with 5 intercropping systems, viz. sole cowpea, sole baby corn, cowpea + baby corn (2 : 1), cowpea + baby corn (3 : 1) and cowpea + baby corn (4 : 1) in main plot, 3 fertility levels (100, 125 and 150% recommended dose of fertilizer) in subplot and 2 stress-mitigating chemicals (0.5% $CaCl_2$ and 1% $KNO_3$ at flowering and pod development stages) in sub-subplot and replicated 4 times. Data revealed that, 2 : 1 row ratio of cowpea and baby corn significantly increased the yield attributes of cowpea as well as baby corn over all the remaining row ratios and sole crops. Yields of both crops were significantly higher under their sole cropping and yield decreased significantly in intercropping due to reduction in plant population. In the subplot, all yield attributes and yields of both crops were higher with the fertility level of 150% over lower levels (100% and 125%). The yield attributes and yields of both crops were significantly higher with the foliar spray of 0.5% of $CaCl_2$ over 1% $KNO_3$.

***Key words*:** Cowpea + baby corn intercropping system, Fertilization, Foliar spray, RDF, Quality, Yield

Cowpea is an important multipurpose grain legume, extensively cultivated in arid and semi-arid tropics. It is grown as catch crop, mulch crop, intercrop, mixed crop and green-manure crop. The cowpea cultivation is gaining popularity among growers owing to short duration, quick-growing nature, soil-enriching habit, higher yield and higher profitability/unit area and hence gradually replacing the other traditional summer legume crops. Cowpea has been intercropped for long time with various other crops such as maize, sorghum and millets. Baby corn is dehusked maize ear, harvested within 2–3 days of silk emergence but prior to fertilization. Baby corn is consumed as vegetable owing to its sweet flavour. High nutritional value, eco-friendly and crispy nature of baby corn has made it special choice for various traditional and continental dishes apart from canning in the elite society (Singh *et al*., 2006). It can be consumed raw or used as an ingredient in wide variety of dishes across the globe. Baby corn can be grown round the year and 3–4 crops can be taken in 1 year. After the harvest of babies, the economic potential is further enhanced since it supplies green, soft, succulent, nutritious, palatable fodder with higher digestibility (Ramachandrappa *et al*., 2004).

Intercropping can be defined as the production or growing of two or more crops simultaneously in the same piece of land (Ofori and Stern, 1987). The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height and nutrient requirement based on the complementary utilization of growth resources by the component crops. Better use of nutrients can be possible owing differences in rooting pattern which may also occur because of mutual avoidance of different root-system (Trenbath, 1974).

Greater uptake of different nutrients and better use of water by intercropping are also possible. The

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complementarity may be temporal when the growth patterns of component crops differ in time, so that the crops make their major demands on resources at different times. By temporal use of resources, yield advantages have been obtained with crops having marked differences in maturity period (Willey and Osiru, 1972).

Nitrogen is an essential and important determinant for growth and development of crop plants (Tanaka *et al.,* 1984). Phosphorus is also an essential nutrient both as a part of several key plant-structure compounds and as a catalysit in the conversion of numerous key biochemical reactions in plants. Phosphorus is noted especially for its role in capturing and converting the sun's energy into useful plant compounds. It is a vital component of DNA.

During summer season, night temperature at the time of reproductive phase of cowpea in North-West India remains > $20^{o}$C which may adversely affect the flowering and seed setting in cowpea. Reduction in the yield of field crops can be managed by use of foliar bio-regulators, as these can modify plant physiological/ biochemical processes during biotic and abiotic stresses (Kumar *et al.,* 2013). Bio-regulators application on crop enhances the number of flowers, reduces pod drop, improve endogenous content of mineral ions and provide tolerance during heat stress conditions (Kumar *et al.,* 2013, Bons *et al.,* 2015).

With the above facts the experiment was conducted to analyse the interspecies compatibility and production potentials of cowpea and baby corn in intercropped association. Cowpea and baby corn are important crops. The former is a high protein for human being, while the latter is valuable cereal crop.

## METHERIALS AND METHODS

The field experiment was conducted at Agriculture Research Station of the Agriculture University, Ummedganj, Kota, Rajasthan during the summer season of 2019 and 2020. Kota is situated in sub-tropical zone of Vindhyan Plateau of Rajasthan, with the average annual rainfall of 750–1,005 mm. The mean annual maximum and minimum temperatures are 40.2°C and 18.5°C respectively. The summer months are hot and May is the hottest month, having a maximum temperature up to 43.5°C. The soil of the experimental field was medium black clay loam, fairly deep, having good drainage facilities. The mean daily maximum and minimum temperature during the growing season fluctuated between 37.1 and 47.3°C and 17.1 and 33.6°C, respectively, in the year 2019. The corresponding values for 2020 were between 37.0 and 44.5°C and 17.36 and 24.36°C respectively. The average daily relative humidity fluctuated between 24.4 and 74.6% in 2019 and 30.4 and 73.29% in 2020. The mean daily open pan evaporation from USWB class A pan evaporimeter ranged from 2.1 to 5.6 mm/day in 2019 and 2.7 to 5.0 mm/day in 2020. There was rainfall of 50 mm and 58 mm in the year 2019 and 2020 respectively. Summer season's total rainfall recorded during both the years were uniform in amount and distribution. For recording yield attributes of cowpea and baby corn, 5 random plants were selected and labelled. For seed yield of cowpea pods from each net plot (including pods from 5 sample plants) were threshed separately and seeds yields were expressed in kg/ha. After thorough sun-drying of harvested material, weight was taken for biological yield per plot and then converted to kg/ha and by subtracting the seed yield from the biological yield, straw yield was obtained. For obtaining cob yield, the cobs from net plot area were harvested separately treatment-wise. For recording the green-fodder yield, plants from net plot area were harvested by leaving 5 cm stubbles from ground surface and weighed. The total green fodder was expressed in kg/ha.

## RESULT AND DISCUSSION

### *Yield attributes and yield of cowpea*

The result pertaining to yield attributes of cowpea in individual years and pooled analysis revealed that, significantly higher yield attributes of cowpea, viz*.,* pods/plant, pod length, seeds/pod and 100-seed weight, were recorded under cowpea and baby corn 2 : 1 intercropping system (Table 1) over the remaining row ratios and sole cowpea. Significantly higher yield and yield attributes under 3 : 1 row ratio of cowpea and baby corn was also observed over sole cowpea. This might be owing to favourable environment available to plants, as also evident from dry-matter accumulation under this system. Similar results were also observed by Ganvir *et al.* (2004) and Kumawat *et al.* (2018). However, significantly higher seed, straw and biological yields were obtained in sole cowpea over other row ratios of cropping system (Table 3). Yield decreased significantly in intercropping due to reduction in plant population. Devi and Singh (2018), Shukla *et al.* (2019) and Mndezebele *et al.* (2020) also reported the similar results.

Application of successive fertilizer levels up to 150% RDF (30 kg N + 60 kg $P_2O_5$/ha) significantly increased the yield attributes, viz. pods/plant, pod length, seeds/pod test weight seed, straw and biological yield of cowpea (Table 1 ) in both years as well as on pooled basis. The all over improvement in vigour and crop growth was owing to adequate supply of nitrogen early in the life of a plant is considered important in promoting rapid vegetative growth and branching. Thus, N fertilization stimulated seed setting and increased the yield attributes of cowpea. Phosphorus plays an important role in nitrogen-fixation in legumes, where it acts as a source of energy. It plays a pivotal role in early formation of roots, their proliferation, increased microbial activity in nodules and symbiotic biological N-fixa-

**Table 1.** Effect of nitrogen and phosphorus fertilization and stress mitigating chemicals on yield attributes of cowpea in cowpea and baby corn in cropping system

| Treatment | Pods/plant | | | Seeds/pod | | | Pod length (cm) | | | 100-seed weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled |
| *Intercropping system* | | | | | | | | | | | | |
| Sole cowpea | 6.11 | 6.37 | 6.24 | 6.77 | 7.49 | 7.13 | 8.64 | 9.08 | 8.86 | 8.17 | 8.48 | 8.33 |
| Sole baby corn | – | – | – | – | – | – | – | – | – | – | – | – |
| Cowpea + baby corn (2 : 1) | 7.09 | 7.73 | 7.41 | 8.39 | 8.87 | 8.63 | 10.14 | 10.50 | 10.32 | 9.60 | 9.88 | 9.74 |
| Cowpea + baby corn (3 : 1) | 6.70 | 7.20 | 6.95 | 7.93 | 8.40 | 8.17 | 9.48 | 9.80 | 9.64 | 8.98 | 9.25 | 9.12 |
| Cowpea + baby corn (4 : 1) | 6.19 | 6.55 | 6.37 | 7.37 | 7.88 | 7.63 | 9.05 | 9.26 | 9.15 | 8.67 | 8.61 | 8.64 |
| SEm± | 0.09 | 0.12 | 0.08 | 0.08 | 0.12 | 0.08 | 0.13 | 0.15 | 0.10 | 0.16 | 0.17 | 0.12 |
| CD (P=0.05) | 0.29 | 0.37 | 0.25 | 0.24 | 0.38 | 0.23 | 0.40 | 0.45 | 0.29 | 0.48 | 0.54 | 0.34 |
| *Fertility level* | | | | | | | | | | | | |
| 100% RDF | 4.86 | 5.24 | 5.05 | 5.75 | 6.24 | 5.99 | 7.09 | 7.37 | 7.23 | 6.67 | 6.96 | 6.81 |
| 125% RDF | 5.22 | 5.58 | 5.40 | 6.09 | 6.52 | 6.30 | 7.46 | 7.72 | 7.59 | 7.11 | 7.24 | 7.18 |
| 150% RDF | 5.57 | 5.89 | 5.73 | 6.44 | 6.82 | 6.63 | 7.85 | 8.10 | 7.97 | 7.47 | 7.54 | 7.50 |
| SEm± | 0.10 | 0.09 | 0.07 | 0.09 | 0.08 | 0.06 | 0.10 | 0.11 | 0.07 | 0.10 | 0.10 | 0.07 |
| CD (P=0.05) | 0.28 | 0.27 | 0.19 | 0.27 | 0.23 | 0.17 | 0.30 | 0.31 | 0.21 | 0.29 | 0.28 | 0.20 |
| *Stress-mitigating chemical* | | | | | | | | | | | | |
| $CaCl_2$ @ 0.5% at flowering and pod-development stage | 5.44 | 5.82 | 5.63 | 6.26 | 6.68 | 6.47 | 7.64 | 7.90 | 7.77 | 7.21 | 7.39 | 7.30 |
| $KNO_3$ @ 1.0% at flowering and pod-development stage | 5.00 | 5.32 | 5.16 | 5.93 | 6.37 | 6.15 | 7.29 | 7.56 | 7.42 | 6.96 | 7.10 | 7.03 |
| SEm± | 0.08 | 0.07 | 0.05 | 0.08 | 0.08 | 0.05 | 0.07 | 0.09 | 0.06 | 0.07 | 0.08 | 0.06 |
| CD (P=0.05) | 0.23 | 0.21 | 0.15 | 0.22 | 0.22 | 0.15 | 0.19 | 0.26 | 0.16 | 0.21 | 0.23 | 0.16 |

RDF, Recommended dose fertilizer

**Table 2.** Effect of nitrogen and phosphorus fertilization and stress-mitigating chemicals on yield attributes of baby corn in cowpea and baby corn cropping system

| Treatment | Cob length (cm) | | | Cob girth (cm) | | | Cob weight (g) | | | Cobs/plant | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled |
| *Intercropping system* | | | | | | | | | | | | |
| Sole cowpea | – | – | – | – | – | – | – | – | – | – | – | – |
| Sole baby corn | 16.88 | 16.51 | 16.70 | 6.31 | 6.21 | 6.26 | 24.42 | 23.63 | 24.02 | 1.20 | 1.18 | 1.19 |
| Cowpea + baby corn (2 : 1) | 19.50 | 19.04 | 19.27 | 7.35 | 7.18 | 7.26 | 35.00 | 34.00 | 34.50 | 1.72 | 1.71 | 1.72 |
| Cowpea + baby corn (3 : 1) | 18.50 | 17.84 | 18.17 | 7.06 | 7.00 | 7.03 | 30.08 | 29.75 | 29.92 | 1.45 | 1.44 | 1.45 |
| Cowpea + baby corn (4 : 1) | 17.50 | 17.11 | 17.30 | 6.57 | 6.35 | 6.46 | 26.54 | 25.46 | 26.00 | 1.24 | 1.26 | 1.25 |
| SEm± | 0.23 | 0.34 | 0.21 | 0.10 | 0.11 | 0.08 | 0.47 | 0.54 | 0.38 | 0.02 | 0.03 | 0.02 |
| CD (P=0.05) | 0.72 | 1.04 | 0.62 | 0.29 | 0.35 | 0.24 | 1.45 | 1.67 | 1.11 | 0.05 | 0.09 | 0.05 |
| *Fertility level* | | | | | | | | | | | | |
| 100% RDF | 13.56 | 13.23 | 13.39 | 5.14 | 4.98 | 5.06 | 22.34 | 21.39 | 21.87 | 1.05 | 1.04 | 1.05 |
| 125% RDF | 14.48 | 14.13 | 14.31 | 5.46 | 5.35 | 5.41 | 23.22 | 22.72 | 22.97 | 1.12 | 1.13 | 1.12 |
| 150% RDF | 15.38 | 14.94 | 15.16 | 5.77 | 5.71 | 5.74 | 24.07 | 23.59 | 23.83 | 1.20 | 1.18 | 1.19 |
| SEm± | 0.26 | 0.26 | 0.19 | 0.09 | 0.09 | 0.06 | 0.28 | 0.28 | 0.20 | 0.02 | 0.02 | 0.01 |
| CD (P=0.05) | 0.76 | 0.75 | 0.52 | 0.26 | 0.25 | 0.18 | 0.80 | 0.82 | 0.56 | 0.06 | 0.05 | 0.04 |
| *Stress mitigating chemical* | | | | | | | | | | | | |
| $CaCl_2$ @ 0.5% at flowering and pod-development stage | 14.82 | 14.50 | 14.66 | 5.68 | 5.55 | 5.61 | 23.67 | 23.02 | 23.34 | 1.16 | 1.16 | 1.16 |
| $KNO_3$ @ 1.0% at flowering and pod-development stage | 14.13 | 13.70 | 13.92 | 5.24 | 5.14 | 5.19 | 22.75 | 22.12 | 22.43 | 1.08 | 1.08 | 1.08 |
| SEm± | 0.21 | 0.20 | 0.14 | 0.08 | 0.07 | 0.05 | 0.23 | 0.24 | 0.17 | 0.02 | 0.02 | 0.01 |
| CD (P=0.05) | 0.60 | 0.57 | 0.41 | 0.22 | 0.19 | 0.15 | 0.67 | 0.67 | 0.47 | 0.05 | 0.05 | 0.03 |

RDF, Recommended dose of fertilizer

tion process. Balai *et al.* (2017), Shilpa and Wali (2018) and Mndezebele (2020) reported increased yield attributes, seed, straw and biological yields in cowpea with the combined application of fertilizers (N and P).

Application of $CaCl_2$ @ 0.5% at flowering and pod development stages resulted in significantly higher number of pods/plant, seeds/pod, pod length, 100-seed weight, seed, straw and biological yields of cowpea over $KNO_3$ @ 1.0% at flowering and pod-development stages during the both years. The increase in pod and grain yield by application of $CaCl_2$ might be owing to fact that, availability of $Ca^{+2}$ to plants plays an important role in many biochemical processes, delaying senescence, regulation of plant activities, especially through protein phosphorylation (Wahid *et al.,* 2007). Kumar (2014) and Bohra reported a significant increase in yield attributes and yield of Egyptian clover and cowpea owing to the beneficial effect of $CaCl_2$.

### *Yield attributes and yield of baby corn*

Different row ratios of cropping system in cowpea and baby corn resulted in significantly higher yield attributes, viz. cob length, cobs/plant, cob weight and cob girth of baby corn than sole baby corn (Table 2). Among different row ratios of cowpea and baby corn, 2 : 1 row ratio significantly higher yield attributes of baby corn over 3 : 1 and 4 : 1 row ratio. Baby corn intercropped with legumes gets better environment for growth and development and these treatments have the added advantage of more N availability because of leguminous intercrops. This made baby corn under intercropped situation to grow taller, and to accumulate more dry-matter, taller plants with higher dry-matter accumulation that offered better translocation of the stored food from source to sink which might have resulted in more cob length. Similar results were also reported by Rehman *et al.* (2010) and Amini *et al.* (2013). However, significantly higher cob and green fodder yield were obtained in sole baby corn than other row ratios of cowpea and baby corn and this was decreased significantly in intercropping because of reduction in plant population (Table 4).

The fertility levels resulted in marked improvement in the yield attributes, viz. cobs/plant, cob length, cob girth and cob weight. The fertility level of 150% RDF registered the highest yield attributes. Cob and green-fodder yields were also significantly highest at fertility level of 150% RDF. Increase in yield attributes, cob and green-fodder yields could be attributed to the favourable effect of higher levels of nutrient application on yield attributes. Increased level of NPK might have provided the crop with a balanced nutrient supply, resulting in improved growth and yield attributes such as plant height, leaf-area index and dry-matter production and consequently increased the yield

**Table 3.** Effect of nitrogen and phosphorus fertilization and stress-mitigating chemicals on seed, straw, biological yield and harvest index of cowpea in cowpea and baby corn cropping system

| Treatment | Seed yield (kg/ha) | | | Straw yield (kg/ha) | | | Biological yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled | 2019 | 2020 | Pooled |
| *Intercropping System* | | | | | | | | | |
| Sole cowpea | 700 | 812 | 756 | 1,094 | 1,212 | 1,153 | 1,794 | 2,024 | 1,909 |
| Sole baby corn | – | – | – | – | – | – | – | – | – |
| Cowpea + baby corn (2 : 1) | 469 | 556 | 513 | 730 | 850 | 790 | 1,200 | 1,406 | 1,303 |
| Cowpea + baby corn (3 : 1) | 507 | 595 | 551 | 772 | 887 | 829 | 1,279 | 1,482 | 1,381 |
| Cowpea + baby corn (4 : 1) | 550 | 661 | 606 | 905 | 997 | 951 | 1,455 | 1,658 | 1,557 |
| SEm± | 10.8 | 12.9 | 8.8 | 15.9 | 19.5 | 13.3 | 21.4 | 21.4 | 15.6 |
| CD (P=0.05) | 33.3 | 39.8 | 25.6 | 49.1 | 59.9 | 38.9 | 65.9 | 65.9 | 45.4 |
| *Fertility level* | | | | | | | | | |
| 100% RDF | 407 | 482 | 444 | 660 | 730 | 695 | 1,066 | 1,212 | 1,139 |
| 125% RDF | 451 | 525 | 488 | 698 | 788 | 743 | 1,150 | 1,314 | 1,232 |
| 150% RDF | 478 | 567 | 523 | 742 | 850 | 796 | 1,220 | 1,417 | 1,318 |
| SEm± | 7.8 | 10.0 | 6.3 | 12.0 | 14.2 | 9.3 | 13.1 | 18.2 | 11.2 |
| CD (P=0.05) | 22.4 | 28.8 | 17.9 | 34.8 | 40.9 | 26.3 | 37.8 | 52.7 | 31.7 |
| *Stress mitigating chemical* | | | | | | | | | |
| $CaCl_2$ @ 0.5% at flowering and pod-development stage | 458 | 539 | 499 | 717 | 815 | 766 | 1,175 | 1,354 | 1,265 |
| $KNO_3$ @ 1.0% at flowering and pod-development stage | 433 | 511 | 472 | 683 | 763 | 723 | 1,116 | 1,274 | 1,195 |
| SEm± | 6.1 | 7.6 | 4.9 | 8.9 | 12.1 | 7.5 | 10.7 | 14.5 | 9.0 |
| CD (P=0.05) | 17.5 | 21.5 | 13.7 | 25.3 | 34.4 | 21.0 | 30.4 | 41.2 | 25.3 |

RDF, Recommended dose of fertilizer

**Table 4.** Effect of nitrogen and phosphorus fertilization and stress-mitigating chemicals on cob, fodder yield and harvest index of baby corn in cowpea and baby corn cropping system

| Treatment | Cob yield (kg/ha) | | | Fodder yield (kg/ha) | | |
|---|---|---|---|---|---|---|
| | 2019 | 2020 | Pooled | 2019 | 2019 | 2019 |
| *Intercropping System* | | | | | | |
| Sole cowpea | – | – | – | – | – | – |
| Sole baby corn | 4,207 | 4,092 | 4,150 | 16,367 | 16,046 | 16,207 |
| Cowpea + Baby corn (2:1) | 2,295 | 2,210 | 2,253 | 9,100 | 8,735 | 8,918 |
| Cowpea + Baby corn (3:1) | 1,746 | 1,593 | 1,669 | 6,903 | 6,348 | 6,625 |
| Cowpea + Baby corn (4:1) | 1,146 | 1,051 | 1,098 | 4,508 | 4,123 | 4,316 |
| SEm± | 32.6 | 34.0 | 24.8 | 136.1 | 137.5 | 97.8 |
| CD (P=0.05) | 100.6 | 104.8 | 72.3 | 419.3 | 423.6 | 285.5 |
| *Fertility level* | | | | | | |
| 100% RDF | 1,799 | 1,700 | 1,750 | 7,112 | 6,758 | 6,935 |
| 125% RDF | 1,884 | 1,791 | 1,837 | 7,378 | 7,053 | 7,215 |
| 150% RDF | 1,954 | 1,876 | 1,915 | 7,637 | 7,340 | 7,489 |
| SEm± | 23.6 | 28.8 | 18.6 | 86.9 | 96.0 | 64.7 |
| CD (P=0.05) | 68.0 | 83.2 | 52.7 | 250.9 | 277.3 | 183.2 |
| *Stress-mitigating chemical* | | | | | | |
| $CaCl_2$ @ 0.5% at flowering and pod-development stage | 1,912 | 1,823 | 1,867 | 7505 | 7,209 | 7,357 |
| $KNO_3$ @ 1.0% at flowering and pod-development stage | 1,846 | 1,756 | 1,801 | 7246 | 6,892 | 7,069 |
| SEm± | 21.2 | 23.0 | 15.6 | 81.5 | 110.3 | 68.6 |
| CD (P=0.05) | 60.4 | 65.6 | 44.0 | 232.1 | 314.1 | 192.6 |

RDF, Recommended dose of fertilizer

attributes and yield of baby corn. It was also possible owing to slow and continuously nutrient supply by NP. Similar results were reported by Sobhana *et al.* (2012), Kumar and Bohra (2014), and Balai *et al.* (2017).

It was observed that, spray of 0.5% $CaCl_2$ significantly increased the yield attributes, viz. cob length, cob girth, cob weight, cobs/plant, cob yield and green-fodder yield over spray of 1% $KNO_3$ during both years and in pooled mean analysis (Tables 2 and 4). This might be owing the to differential effect bio-regulator in manipulating plant responses and modifing plant gene expression, affecting levels of DNA, RNA, enzymes and hence significant effect on yield and quality of crops (Olaiya *et al.,* 2013). The beneficial effect of foliar spray of calcium was also observed in maize by Naeem *et al.* (2017).

Author, please give concluding paragraph

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